



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

University of Pretoria RESEARCH REVIEW 2016





Front cover: Thousands of gold beads that symbolised royalty, wealth and power were recovered from three burials on Mapungubwe Hill (AD 1220–AD 1290). These sacred objects of the past served as adornment and ritual, and probably also signified economic, political and social status, and today are revered and conserved as national treasures. This page: Mapungubwe recurved jar (265mm x 360mm), burnished earthenware, Mapungubwe National Heritage Collection, No. N/219.

University of Pretoria RESEARCH REVIEW 2016

UP

a leading
research university
in Africa

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An e-version of this Review, and a full listing of the University's research publications in 2016, are available with links and access to listed publications at:
<http://www.up.ac.za/research-innovation>

FOREWORD

The University of Pretoria prides itself on being a research leader in Africa, and each year the innovative work of some of our emerging and lead researchers are showcased in a Research Review.

Aligned with areas of research strength where the University has distinguished itself, the focus in 2016 continued to be on ‘research that matters’ in thematic areas that demonstrate our commitment to engage with societal issues and, by so doing, to contribute to a better future. The University’s areas of strategic focus are featured in this Review, with its theme-based structure aligned with the United Nations Sustainable Development Goals (SDGs), Agenda 2030, the African Union’s Agenda 2063 – *the Africa We Want*, and *Our Future – Make It Work* and South Africa’s National Development Plan 2030. Whether the frameworks are global, regional or national in scope, the message is clear: UP investigates, discovers and innovates through research that matters.

There is growing recognition in the science community that universities as public institutions should contribute to the growth, development and wellbeing of societies and that new ways of doing science to effectively address complex problems are needed: from deliberately taking as point of departure the problem itself to frame different dimensions to the investigation, to what has more recently come to be referred to as convergence science that cuts across disciplinary boundaries and makes possible a new synthesis of methods, theories and approaches.

Six themes structure this Review, each framing our focus on research in and for Africa. While texts foreground many problems and challenges, there are strong signs of hope and possibilities for change: be it through research findings, or in substantive policies and guidelines, or through the visible monitoring of accountability. Clearly manifest and woven through each theme is the role and contribution of young scientists, and each theme, especially the theme on *Human rights*, foregrounds women and children as central to societies’ wellbeing and to our sustainable futures.

A few examples are chosen to illustrate this sense of hope and renewal through science: Theme 1—*Development and the economy* shows the centrality of leadership legitimacy and authenticity in African research on leadership, and in another example, the centrality of networks and relationships in resilient organisations. Theme 2—*Human*

rights amply illustrates in several texts the interaction between research, publishing and advocacy, and the wide collaboration with strategic partners, in order to affect the change envisaged; the theme also demonstrates the recognition UP researchers have received internationally. Theme 3—*Heritage and society* takes as a point of departure ancient texts and a rich cultural heritage, given the antiquity of human occupation in southern Africa; and as another, the contemporary risks, inequalities and ‘forgotten people’ that provide insight into the role of science and research, and what still remains to be challenged and addressed. Theme 4—*Health* covers both human and animal health with a cross-cutting focus on issues central to wellbeing, most often addressed in collaboration with local, regional and/or international partners; from malaria control and eradication, to re-engineering primary health care, to wildlife reproduction. Theme 5—*Natural environments* underscores the centrality of science in informing our understanding of critical environmental issues, with texts demonstrating contemporary approaches and research tools, from microbial studies to mathematical modelling. Theme 6—*Plant production and food security* concludes the thematic focus on research relevance at UP, and is framed by ecological transformations brought about by climate change, sustaining woody ecosystems and planted forests, and the critical importance of global strategies to monitor pest and pathogen movement and to mount appropriate outbreak responses. Again, wide-ranging partnerships underscore the importance of team (and theme) science in sustaining excellence in research.

A key strategy in 2016 was for the University to increase its high impact research in knowledge fields of relevance to developing regions and Africa, in particular. The examples covered in this review provide ample evidence that this strategic focus was successfully accomplished.

On behalf of the University, I wish to express our gratitude to all our research partners, collaborators and funders. Your generosity has enabled the research that matters locally and globally.

Professor Cheryl de la Rey
Vice-Chancellor and Principal, University of Pretoria



INTRODUCTORY MESSAGE

The production of the Research Reviews is always a highlight in the annual research calendar of the University of Pretoria, and the UP Research Review 2016 is no exception.

Our commitment is to pursue research that matters, and to do so in ways that underscore quality, impact and excellence. This commitment speaks directly to the University's long-term vision: to be a leading research-intensive university in Africa, recognised internationally for our quality, relevance and impact, and also for developing people, creating knowledge and making a difference locally and globally. The year 2016 concluded the first five-year implementation cycle of the University's long-term strategic plan, UP 2025, and it has been possible to follow clear trends in the progress we have made towards the achievement the strategic goals and targets set five years ago, and of the challenges that remain. A critical point of reference has been the development and final adoption, in September 2015, of the United Nations Sustainable Development Goals (SDGs). The seventeen goals frame much of what is now considered to be a necessary and overdue call to action, effectively to address the major challenges that confront our 21st century world – at global, regional and national levels.

Research is one mode of response to the challenges, and universities have an important role to play in contributing to the achievement of the SDGs in our African region, and globally. The research showcased in this Review illustrates many ways in which UP actively pursues research that has an impact on development, wellbeing and social justice. There are many more examples, but each year we deliberately attempt to showcase new examples, and different dimensions to old narratives, of research at UP. The Vice-Chancellor and Principal's Foreword outlines the themes that cluster the content presented here: *development and the economy, human rights, heritage and society, health, natural environments, and plant production and food security* – each emphasising the importance of sustainable development. My task is to provide, in overview, a brief analysis of research achievements in 2016 to provide a broader contextual background to the content of this Review.

At the core of the University's research strength are our staff and young, emerging scientists, and a research environment that makes it possible for researchers to thrive. In 2016, 63.4% of our academic staff held doctoral degrees, the number of postdoctoral fellows recruited to become part of UP's research community stood at 237, and postgraduate students as a percentage of overall enrolment was 37%. There has been a 51% increase in doctoral graduates since 2012, and year-on-year there has been an increase in doctoral enrolment. The benefits of UP's focus on areas of research strength have stimulated cross-disciplinary cooperation, research productivity, the strategic targeting of postgraduate students and postdoctoral fellows, and external funding.

Funding for research increased in 2016 by 22% from 2015, and the University obtained state-of-the-art research equipment to the value of R14m.

Research capacity is further demonstrated in the number of Research Chairs and Centres of Excellence, and UP's leading Research Institutes and Centres. In 2016 there was a total of 113 research entities: 84 Institutes and Centres; 29 industry and internationally sponsored Research Chairs; and, taken together, 20 DST-NRF South African Research Chairs Initiative (SARChI) Chairs, Centres of Excellence, and Medical Research Council Units.

In a sector-wide analysis of research performance in 2015, undertaken by the national Department of Higher Education and Training in 2016, the University of Pretoria performed well: in terms of overall research output, it ranked the highest in South Africa, and also the highest with respect to the weighted per capita output (of publications, plus master's and doctoral graduates). While this sector-wide analysis is still pending for 2016, the University anticipates that it will maintain a leading position with respect to research output, with audited institutional data showing a 14.4% increase in journal articles alone. This is testament to the success of several initiatives that have been implemented to support research at the University.

Regional and international partnerships at the University are driven through strategic institutional and faculty agreements, and, importantly, through expanded research networks, as are reflected in the number of co-authored papers with international researchers, as well as in the increased intake of international postgraduate students and postdoctoral fellows. However, partnerships are more than publications. As many of the research profiles presented in this Review illustrate, it is also about research informing policy, and about active partnerships in the implementation of policies towards the achievement of sustainable development that leaves no one behind.

I hope that the progress made, and the relevance and impact of the excellent research being done at the University of Pretoria, are evident to readers. I would like to extend my sincere gratitude to those who are doing the research, and to all who have contributed to this Review.

Professor Stephanie Burton

Vice-Principal: Research and Postgraduate Education

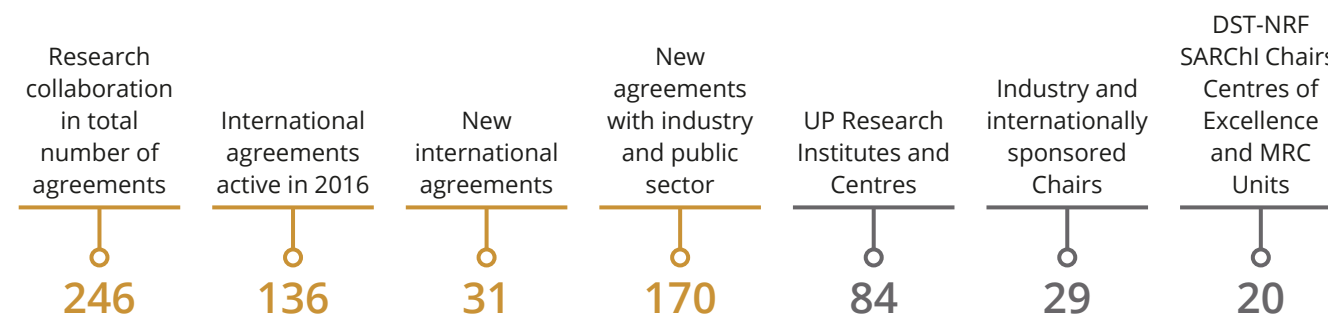


RESEARCH OVERVIEW

The University of Pretoria has achieved significant progress in the first five years of implementing its long-term strategic plan, UP 2025. The increase in research productivity, the growing number of staff with doctorates and of those who have achieved an NRF rating as an indication of their recognition and standing as scientists, as well as the increase in doctoral enrolments, and in doctoral and master's graduates, all contribute to the University's research-intensive identity. Closely coupled to research performance is the strengthening of our international profile and visibility, the consolidation of research capacity in Research Chairs, Institutes and Centres, and through the active collaboration with regional and international partners. Presented here are the main trends in 2016 that have contributed to this achievement.

REGIONAL AND INTERNATIONAL COLLABORATION

Research collaboration on the African continent and internationally is reflected in several measures.

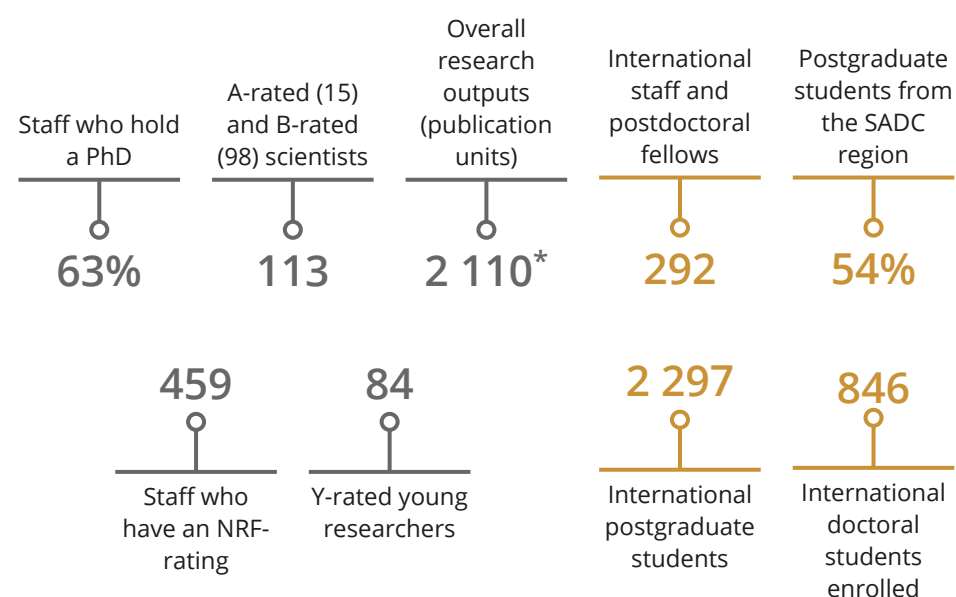


RESEARCH CHAIRS

Research capacity is consolidated in many research entities that provide opportunities for team science and collaboration.

STAFF AND RESEARCH OUTPUT

Research capacity is closely tied to the quality and recognition of researchers at UP.

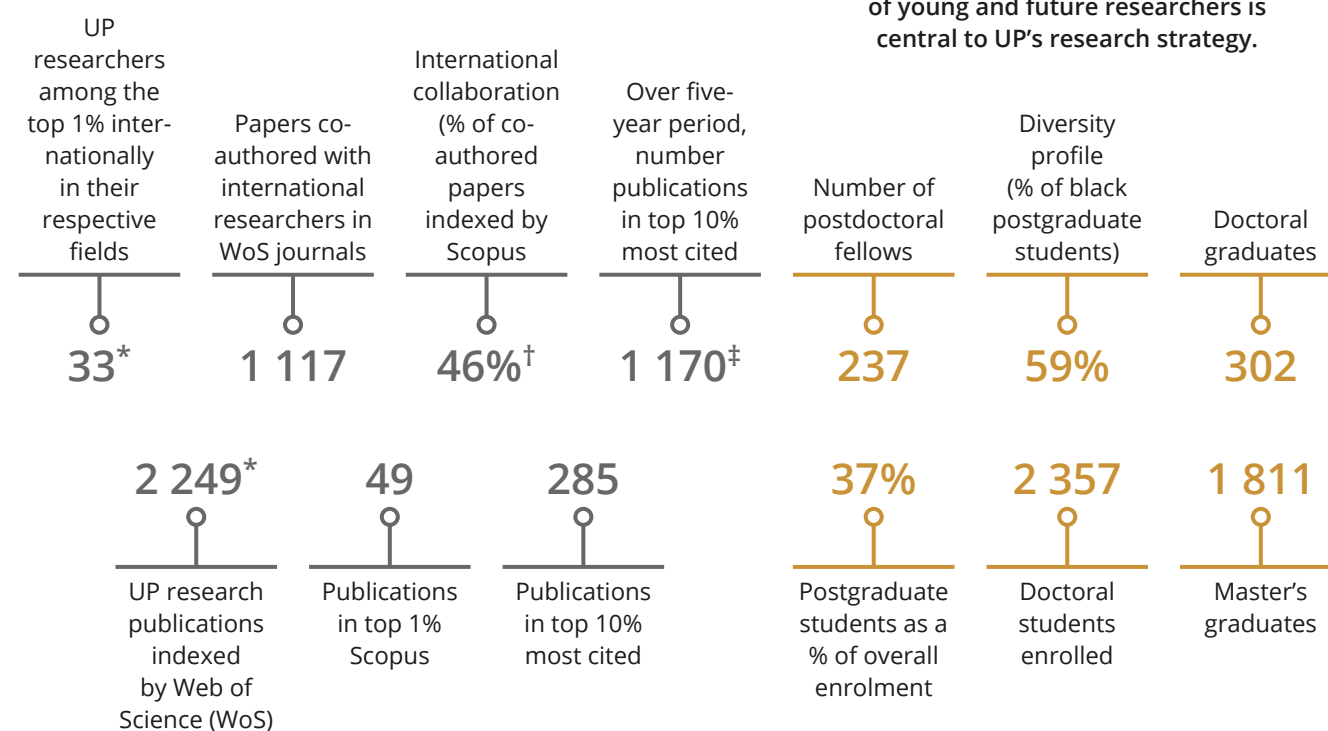


INTERNATIONAL STAFF AND STUDENTS

UP's international profile has grown considerably.

INTERNATIONAL VISIBILITY AND IMPACT

UP actively engages in international partnerships that align with our strategic goals and areas of research strength.



NEXT-GENERATION RESEARCHERS

Building and strengthening the pipeline of young and future researchers is central to UP's research strategy.

For more information



Data as in December 2016, except where indicated differently.
* Provisional, as on 15 May 2017.

* WoS Essential Science Indicators, January 2017; InCites, 31 May 2017; † Scopus, 3 July 2017; ‡ SciVal 2012–2016, July 2017



THEMES

UP

research
that matters

DEVELOPMENT
AND THE ECONOMY

HUMAN RIGHTS

HERITAGE AND SOCIETY

HEALTH

NATURAL ENVIRONMENTS

PLANT PRODUCTION
AND FOOD SECURITY

The six themes that group the research profiled in this Review speak to the University of Pretoria's commitment to engage with societal issues and, through research, to contribute to a better future for all. The themes align with a range of policies and plans, including the United Nations Sustainable Development Goals (SDGs), the African Union's Agenda 2063 and South Africa's National Development Plan 2030. Whether the frameworks are global, regional or national in scope, the message is clear: universities as public institutions are called upon to undertake research that is relevant and can inform future actions. The six themes underscore UP's strategic focus on 'research that matters', contributing to development and wellbeing, social justice, health, the environment and food security.



DEVELOPMENT AND THE ECONOMY

The texts grouped under this theme illustrate research related to development and the economy: from women in the workplace, the risk and survival of small businesses, stock markets, and African markets, to leadership, new rules for social justice, and developmental states. Each provides a different dimension to the challenges faced by developing regions, in particular. The theme concludes by shifting to materials science and collaboration with industry in fixing old industrial equipment and finally, to energy – the demands for sustainable and clean energy, smart grids and integrating renewal energy sources, and the potential to ‘outsmart nature’ by harvesting light.

12 Women and the workplace **14** Business rescue – the idea of reasonable prospect **15** South African markets and investor actions **16** Leadership and development in Africa **17** Understanding business and management in Africa **18** New rules for global justice **19** Developmental states are not there for the taking **20** Collaborative research saves the day for local heavy industry **22** Energy **23** Sustainable clean energy at low cost and high efficiency **24** Smart grids – integrating renewable energy **25** Light-harvesting – outsmarting nature

WOMEN AND THE WORKPLACE

Every research article about women and work used to begin with a statement such as 'women are entering the workforce in numbers unprecedented in history'. More recently, the focus has shifted.

Researchers want to dig deeper to understand what the workplace is like for women and, more specifically, what it is like for women of various demographic groups; how women get ahead and advance their careers when family and cultural identities get in the way of work identities; and, at a macro-level, if having more women is 'good for business'.

Professors Nkomo and Hoobler and Dr Carrim, in the Department of Human Resource Management at UP, are taking the next steps, and are asking questions in their research about what gender means today for women's careers, and also for business organisations.

Dr Nasima Mohamed Hoosen Carrim considers questions of how South African Indian women's identities – that of mother, sister, and unmarried daughter – intersect with their workplace identities and career aspirations. The intersectionality of these identities, and the 'identity work' of South African Indian career women, is the crux of her work. She writes that Indian parents are torn between ensuring that daughters maintain their honour and dignity as 'respectable Indian women', and allowing their daughters the freedom to venture away from the protective space of the home and family.

Professor Jenny Hoobler's research focuses on how family identities intersect with women's career roles and career success. She has used data collected from employees and supervisors of a Fortune 1000 US company to analyse work and family conflicts, their impact on supervisors' perceptions of employees' engagement at work, and ultimately the career success of women employees, as indicated by performance ratings and salary. In further work, she examines the relationships between domestic workers and career women who employ them, and how work-family conflict may 'trickle down' from domestic employers to affect the family situations of their domestic employees. She writes that domestic workers in most developing nations are the 'forgotten persons central to the work-family balancing act'.

Together with Professor Nkomo and two other researchers, Hoobler has published the results of a meta-analysis that seeks to answer one of the big questions in gender and diversity in organisations by testing the 'business case' for women leaders: Does having more women leaders have a positive or negative impact on the 'bottom line' of businesses? They found conclusive results, suggesting that women's leadership may enhance organisational performance, in general, and sales performance, in particular; and further, that the positive effect on firm performance is more likely in gender egalitarian national cultures.



Stella Nkomo, Jenny Hoobler and Nasima Carrim



Their 'sometimes yes' conclusion calls for more sophisticated leadership research that goes beyond counting the number of women leaders, and instead, focuses on measuring gender and mechanisms that link leadership to organisational performance. The paper, accepted in the *Journal of Management*, has been nominated for the 2017 Saroj Parasuraman Outstanding Publication on Gender and Diversity in the Academy of Management Organisational Behaviour division.

Professor Stella Nkomo is an international thought leader in gender and diversity in organisations. She received a National Research Foundation (NRF) A-rating in 2016, publishing work that is very much in line with her commitment to giving back to, and developing, young scholars. An article published in the *Journal of Corporate Citizenship* (June 2016) sketches her journey as a young black scholar in the United States, and finding her way to the topic of study that would become her lifetime passion – gender and diversity in organisations. A co-authored book chapter on practices of managing diversity in emerging countries is a good example of her devotion to organisational scholarship in developing nations. The work contrasts three developing nations: India, Pakistan and South Africa, and illustrates how developing nations are responding to macro-level forces, such as legislation and immigration, in organisational diversity policy.

BUSINESS RESCUE

THE IDEA OF REASONABLE PROSPECT



In line with international regulation practices, the South Africa's Companies Act 71 of 2008 came into effect in 2011. One of the purposes of Chapter 6 of the Act is 'to provide for the efficient rescue and recovery of financially distressed companies, in a manner that balances the rights and interests of all relevant stakeholders'.¹

The central point in the implementation of a new Business Rescue (BR) regime and the related regulation is to promote the development of South Africa's economy.

Professor Marius Pretorius in the **Department of Business Management** at UP has been investigating the success, or not, of different aspects of the new BR regime. Widely recognised as an expert researcher in business rescue, he is often called upon for

advice and also provides guidance to the Regulator. Pretorius and his colleagues, including postgraduate students, have published on tasks, competencies, rescue plans, reasonable prospect, post-mortem analysis, post-commencement finance, and more. However, his research is both practical and intended to be useful, and not merely an academic exercise. In support of the new legislative framework, the Department offers a Certified Rescue Analyst (CRA) training programme for Business Rescue Practitioners (BRPs) and short courses through Enterprises@UP. The main aim is to prepare BRPs in decision-making and executing complex problem solving.

In 2016, Professor Pretorius completed a detailed study for the Companies and Intellectual Property Commission (CIPC) of the Department of Trade and Industry (dti) on the status of business rescue proceedings in South Africa. The study revealed

several shortcomings in the regime. For example, the generic determination of 'reasonable prospect' was identified as a key determinant of conflict and uncertainty. Pretorius notes that reasonable prospect is not 'due diligence', and that it remains largely a vague concept in business rescue. One of the reasons for this state of affairs is that in the early stages where reasonable prospect determination is required, decisions often hinge on incomplete information and, in some cases, the lack of data integrity.

The importance of reasonable prospect, and its role in business rescue, has only more recently started to become clear through academic research and the analyses of BRP techniques and case judgements. While some tools exist within the industry to determine the factual status of reasonable prospect, BRPs see data generated in the process of undertaking specific cases as their 'intellectual property', and therefore the knowledge and understanding gleaned are not widely available for scrutiny.

A further shortcoming identified in the successful implementation of the new legislation relates to the role, competencies and accountability of BRPs. Pretorius writes that the causality of business decline has been the topic of research for many decades, with reasons grouped in two main categories: strategic and operational. It is crucial that BRPs have the competencies to make sense of what the best future alternative for a business is, and have the skills to successfully navigate the business out of its decline.

¹ <http://www.justice.gov.za/legislation/acts/2008-071amended.pdf>



SOUTH AFRICAN MARKETS AND INVESTOR ACTIONS

Efficient markets have several benefits that include protecting investors from bad decisions, and reducing the cost of capital. Researchers at GIBS have examined these aspects of market decisions.

Professor Mike Ward holds the **Chair of Finance** at the **Gordon Institute for Business Science (GIBS)**. His research interests are in investment and corporate finance. Working in collaboration with **Chris Muller**, an independent fund manager and an active participant in financial markets, ensures that their research 'is grounded in practical reality'.

In work published with **Nishal Moodley** in the *Journal for Studies of Economics and Econometrics*, they analyse the trading habits of directors of Johannesburg Stock Exchange (JSE) listed companies. The central question that framed their research was whether it is a good idea for investors to follow the actions of directors who buy or sell their own shares. In terms of the Insider Trading Act of 1999 and JSE regulations, directors are required to report all share trading in companies of which they are principals. Directors who buy or sell shares provide an indirect signal to the market of positive or negative insider information, and the assumption is that investors are likely to trade on signals, even though they have no direct knowledge of the rationale underlying director trades.

The researchers examined 13 840 director trades from 2002–2013, using a portfolio time series approach, and found statistically and economically significant returns for investors who mimic director trades. In particular, they found evidence that directors know when to buy their own shares, but may be selling for a variety of other reasons,

such as monetising or portfolio rebalancing, and not necessarily on the basis of negative insider information. They conclude that directors' selling of shares provides a weaker signal of the future performance of the company than is the case with directors' buying of shares.

Further research published with **Taryn Moodley** in the *SA Journal of Accounting Research*, focused on the working capital strategy of companies, in particular the relationship between the management of payables and the return to investors. The analysis was based on an extensive database of JSE-listed South African companies over the period 1986–2014. The results show that for those companies in industries that have a significant investment in payables, there is a strong positive association between changes in payable days and shareholder return, which supports the general theory of working capital management.

Ward and Muller have also examined the usefulness of the Capital Asset Pricing Model (CAPM) to estimate the returns investors expect, based on the perceived riskiness of the share. They note that this is a controversial issue in finance, as the CAPM is widely used as an investment tool, but doesn't really work in practice. They are also working on a paper showing that investors in mutual funds (unit trusts) shift their money to those funds that performed best in the previous quarter. Their analysis illustrates that unless mutual funds are top performers, investors could see their asset base erode quickly. And finally, through the work of a PhD student they are investigating the interesting problem of why companies that invest more in growing their assets underperform, a problem that contradicts the theory that investing is a value-creating activity – or should be!





Kampala city centre, Uganda – Willem Fourie

LEADERSHIP AND DEVELOPMENT IN AFRICA

Africa is a socioculturally diverse region, and there are numerous attempts at reclaiming some of these sociocultural resources in order to construct authentic forms of African leadership for development.

Willem Fourie, Associate Professor in Social Ethics at UP's Faculty of Theology, and Development Advisor to the African Union's NEPAD Agency, has focused his recent research on the idea of transformative leadership in Africa, and on morality and development. He co-designed and managed, with the **Albert Luthuli Centre for Responsible Leadership** (ALCRL) at UP, a research project on leadership and transformation, funded by the Uongozi Institute in Tanzania. The *Leadership for Africa* project aimed at identifying key enablers and disablers of transformation leadership, with one aspect entailing a review of research published over the past 60 years on leadership in Africa. A co-authored article based on this work has been published in *Leadership*, a prominent international leadership studies journal.

Two key themes emerge: Leadership legitimacy remains a key issue that continues to evolve, and is reflected, for example, in the African value

and implications of Ubuntu. In turn, leadership authenticity is a key emerging issue, as most of the research on African leadership theory still originates from outside Africa. Fourie comments that current and future generations of leadership scholars 'would do well to develop theory based on African experiences and sociocultural resources and to establish dialogue with those theories developed and tested outside Africa'.

The *Leadership for Africa* project is innovative both in terms of its methodology and its foci. It uses cases of transformational change as the starting point for identifying enabling and disabling factors for transformative African leaders. It is also one of the very few projects of this nature that does not use leadership theory developed elsewhere as point of reference, but rather seeks to develop African leadership theory in dialogue with existing theory.

The project also laid the foundation for more conceptual research on the nature of leadership and morality in Africa. In the chapter 'Innovation or impediment: On morality in development', published in *Inclusive Innovation for Sustainable Development* (Springer, 2016), Fourie writes that the patterning of relationships between people is embedded in discernible complexes of positions, and that these positions frame and influence the creation and integration of moralities. And these positions develop so as 'to solve the problems of everyday life'.



UNDERSTANDING BUSINESS AND MANAGEMENT IN AFRICA

How appropriate and transferable are the models from advanced economies when we do business in Africa?

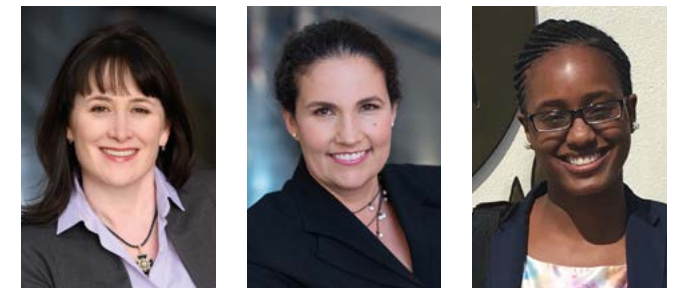
Project Orbit at the **Gordon Institute for Business Science** (GIBS) is driven by an international research team with the specific aim of understanding business and responsible management in Africa. Led by **Professors Nicola Kleyn** and **Helena Barnard**, the team includes postdoctoral fellows, and several international scholars and business partners.

The project aims to gain understanding of how business is conducted in Africa, with a focus on the senior executives of finance, retail and agribusiness companies in Africa, whether they are multinational corporations from South Africa or Europe, or local champion firms.

Several themes were identified in the pilot phase of the project, conducted in 2016 in Namibia, Botswana and Zimbabwe. It shows that many leaders rely on their faith to provide a moral compass in decision-making and strategy in sometimes fraught environments. Networks and relationships are critical to resilient organisations, and even relatively simple tasks such as logistics in a world with infrastructural and institutional voids are challenges to organisations.

One of the exemplar companies is Seed-Co Limited in Zimbabwe, a profitable and research-intensive company. Founded in 1940, and listed on the Zimbabwe Stock Exchange in 1996, the company has over the past decades demonstrated resilience under very challenging circumstances. From their innovative marketing to emerging farmers where agricultural extension is key, to their world-leading research and their commitment to learning French, to better understand Francophone Africa, they offer valuable lessons to firms from across the continent and beyond.

Too often business models from the developed world are uncritically exported to developing countries. The intention with this project is to build models 'from the ground up', and from the lessons learned



Nicola Kleyn, Helena Barnard and Anastacia Mamabolo

in successful business and management. Taken together, the models of business and management that are investigated through this project seek to answer what makes for companies that are profitable in an innovative and non-exploitative manner in a turbulent environment.

HUMAN CAPITAL AND ENTREPRENEURSHIP

Dr Anastacia Mamabolo, a postdoctoral fellow at GIBS, completed her doctoral studies in 2016. Her research interest is the connection between human capital and entrepreneurship in the broader African context. The focus of her PhD was on understanding how skills differ across the entrepreneurship phases, from nascent, to new and to established businesses. The study argued that entrepreneurs are too often treated the same, despite the phase that they are in and the skills they require to run their businesses effectively. Her detailed contribution has been the nature of skills required – entrepreneurial, technical, core business, social and leadership – as entrepreneurship unfolds.

In the second half of 2016, Dr Mamabolo participated in Project Orbit data collection in Namibia and Botswana, and interviewed 32 corporate-level executives. While Project Orbit works with management themes such as global strategies, corporate social responsibility, leadership, networks and institutional environment, her research focus remains on human capital development.

NEW RULES FOR GLOBAL JUSTICE

Today's globalised world means offshore finance, airport boutiques and high-speed Internet for some people, against dollar-a-day wages, used t-shirts, and illiteracy for others. How do these highly skewed global distributions happen, and what can be done to counter them?¹



Professor Lorenzo Fioramonti, Director of the **Centre for the Study of Governance Innovation (GovInn)** at UP, writes that the convergence of crises, from climate change to rampant social and economic inequality, fundamentally questions the main economic paradigm based on growth in the gross domestic product (GDP). Over the past decade, his research has been focusing on new forms of political and economic governance. In 2013, he released *Gross Domestic Problem: The Politics Behind the World's Most Powerful*, and in 2014, *How Numbers Rule the World: The Use and Abuse of Statistics in Global Politics*, both published by Zed Books, London. The books stimulated a stream of research on how measurements affect development policies, social behaviours and governance at large, which is now a growing research field in political and economic studies.

In 2016, Fioramonti co-edited a volume titled *New Rules for Global Justice: Structural Redistribution in the Global Economy*, which tackles some of the most critical challenges facing the international governance systems, from redistribution of resources to inequality, and from new money systems to climate change and migration. The book presents a collection of thought-provoking innovations, authored by some of the world's most innovative experts in these fields. Among several reviewers, Vandana Shiva, recipient of the Alternative Nobel Prize – Right Livelihood Award, writes: “Over the last decades corporate globalisation has imposed an economic system that has produced a world for the 1%, increased global injustice, and pushed the planet and societies to the brink. The ideas and proposals presented in *New Rules for Global Justice* have become an ecological and political imperative”.

Fioramonti's research has always been grounded in the desire to provide evidence-based information to improve governance processes, and to achieve

sustainable and equitable development. This commitment led to the establishment of the Centre for the Study of Governance Innovation (GovInn) at the University of Pretoria, which in 2015–2016 expanded from a handful of researchers to over 30 staff and two offices, one at UP and the other in Cape Town. His work on rethinking development and, above all, his ambition to develop a robust critique of conventional approaches to economic growth has continued unabated.

He is working on two new single-authored books, which will be published in 2017. The first, *The World After GDP: Economics, Politics and International Relations in the Post-Growth Era*, combines several streams of research into a coherent vision for a future global economy, showing the importance of shifting the types of measurements used to understand development and prosperity. The second book, *Wellbeing Economy: Success in a World Without Growth*, will provide a practical roadmap as to how to achieve wellbeing in times of low or no economic growth, with a particular focus on South Africa and Africa.



Aerial photo of Bloubastrand - Johnny Miller

¹ Publisher's note, 2016.

DEVELOPMENTAL STATES ARE NOT THERE FOR THE TAKING

The 1994 post-apartheid breakthrough presented genuine possibilities for equity-based growth and development in South Africa. Why were these not harnessed and realised?

Dr Sihle Moon, research fellow at the **Centre for the Advancement of Scholarship**, and lecturer in **Development Studies** at UP, constructs a carefully considered analysis of the political variables that defined and set in motion South Africa's current socio-economic framework. At the heart of his argument is that the 1994 transition was always a fundamentally flawed and inadequate response to the multifaceted and layered socio-economic and political problems that confronted the country. This also explains why the Reconstruction and Development Programme (RDP), a state-led, equity-driven and largely Keynesian approach, was pushed aside less than two years after its adoption.

More than two decades later, his book, *The Political Economy of State-making in Post-Apartheid South Africa* (Africa World Press, 2017), is a journey into the politics, policies, leadership, ideology and the performance of the state in the post-1994 period.

Seeking to provide an explanation for the failure of a developmentalist path to growth and development, he places politics and political processes where they belong – at the centre of the enquiry, which includes choices made by leadership elites at key junctures in the country's post-apartheid history.

Contrary to the dominant narrative that the RDP's failure can be explained away by invoking the hegemony of neo-liberalism, Moon's analysis shows that there was nothing certain or inevitable about the outcome of events. Instead, the current socio-economic structure represents the triumph of



views of the dominant ideological faction within the ANC leadership elite. His analysis shows that while structure shapes and influences agential action, it does not determine political choices, policy options taken and rejected. Also, ideology matters because developmental state-making inherently implies fundamental change and transformation. A critical measure of success or failure therefore is the extent to which the underlying ideological framework has been disrupted and overturned, and the extent to which the dynamic between 'winners and losers' has been affected. This has not been the case in South Africa.

The conclusions drawn are that the mutually reinforcing structural and agential factors severely limited developmental state prospects in the 1990s. Further, external pressures exerted a powerful influence against the RDP and its state-led developmentalism. But there is always room to manoeuvre. Without a developmental state committed simultaneously to equity and growth, tensions and political instability will continue. However, these state-types cannot be had to order.

COLLABORATIVE RESEARCH SAVES THE DAY FOR LOCAL HEAVY INDUSTRY

The capital-intensive steelmaking, power generation and oil and gas sectors of South Africa's economy have a common challenge – that of remaining competitive in the global market using existing and often ageing production plant.

Industry's collaboration with the physical metallurgy research group of the **Department of Materials Science and Metallurgical Engineering** at the University of Pretoria demonstrates breakthroughs where innovative research has facilitated advances in the local heavy industry to stave off global competition.

The South African stainless and carbon alloy steel industries are facing fierce commercial competition from the Far East. One such example is where high-strength microalloyed plate steels that combine the alloying elements titanium and niobium are produced with modern equipment, for export to the entire global market. These steels cannot be successfully produced at the ArcelorMittal South Africa (AMSA) plate mill in Vanderbijlpark, due to the high hot rolling forces, and the difficulty in shape control associated with steel.

AMSA, through its research collaboration with the Physical Metallurgy Research group at UP, has countered this threat by using a locally abundant alloying element, vanadium, in conjunction with nitrogen. Key to this development was the research that uses precipitation strengthening during transformation of the steel microstructure. Further, by using vanadium (instead of titanium and niobium), and by following hot rolling strategies developed at UP, high roll forces and poor shape could be avoided. The studies modelled the extent of recrystallisation during hot rolling and the impact of recrystallisation on flow stress at elevated temperature.

The work has been published in prominent journals and several postgraduate degrees have been awarded. In 2016, the research leader of the **Industrial Metals and Minerals Research Institute (IMMRI)**, **Dr Kevin Banks**, presented further proposals to Vanitec, a global vanadium organisation, and a three-year research contract was awarded, a first for South Africa.

In the oil and gas sector, collaborative research work, led by **Professor Pieter Pistorius**, was awarded with



the 2016 SAIW Harvey Shacklock Gold Medal Award for a paper presented in Melbourne, Australia in 2016. He has focused on the in-service degradation of welded components due to a relatively rare degradation mechanism, that of graphitisation. In steels operating at elevated temperatures and high pressures, strength is often imparted by iron carbides present at the nano-level. The research involved the characterisation of the service exposed components, the development of welding procedures, and the characterisation of the likely in-service behaviour after repair welding of oil refinery equipment.

Front left: Waldo Stumpf, Roelf Mostert, Rorisang Maubane. Back left: Muthoiwa Netshilema, Kevin Banks, Alison Tuling, Charles Siyasiya, Vinod Kurup, Kofi Annan, Carel Coetzee, Liezl Schoeman, Njingalwazi Magwentshu, Sibusiso Mahlalela. Inset: Pieter Pistorius. Below: Optical micrograph of simulated carbon steel, taken by MSc student, K Lekganyane.



Plate mill operator about to measure the thickness of the red-hot plate rolled from an input slab.





ENERGY

Sustainable energy sources are pivotal to economic and social development worldwide. Goal 7 of the United Nations Development Programme SDGs – *Affordable and clean energy* – underscores the centrality of energy to development and wellbeing, and points to the actions that are required to ensure universal access to affordable electricity by 2030. One in five people across the world do not have access to electricity and, as the demand for energy continues to rise, there needs to be a substantial increase in the production of renewable energy. A global economy reliant on fossil fuels increases greenhouse gas emissions, and drastic changes to our climate systems. It is therefore imperative that the conflict between energy needs and the consequences of increased energy consumption are addressed through sustainable and clean energy production.

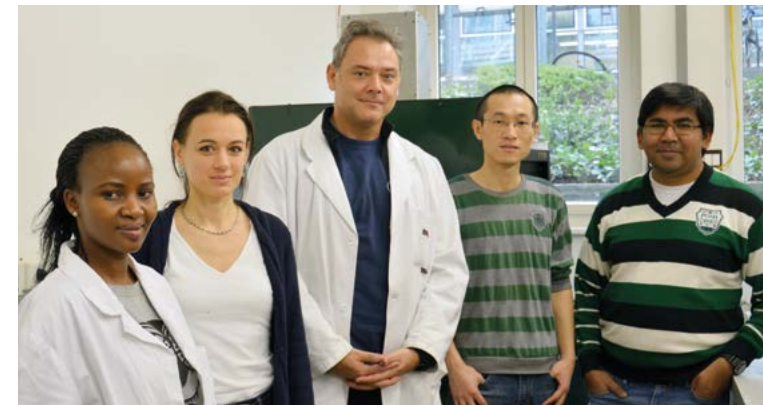
SUSTAINABLE CLEAN ENERGY AT LOW COST AND HIGH EFFICIENCY

It is widely recognised that sustainable energy at low cost would contribute to poverty alleviation and arrest climate change. Fossil fuels for energy contribute directly to global warming by adding carbon dioxide to the atmosphere, as well as to deforestation and climate change. The growing world population adds further urgency to the need to develop systems that can generate cost-effective, efficient, clean and renewable energy.

Professor Mmantsae Diale is the research leader of the Solar Energy Collection and Conversion group in the **Department of Physics**. Her research is directed towards finding low-cost solutions and efficient technologies to collect and store solar energy. Silicon has been used in harvesting solar since the discovery of photovoltaics (PV) several decades ago. Over approximately the same period, the cost of PV has reduced from \$76.00 per watt in 1976 to \$0.30 in 2016, with the price of PV now lower than that of electricity generated from coal. However, clean energy is still expensive for those who need access to off-grid solar power the most.

Professor Diale notes that there are two main challenges associated with the current PV approach: first, the cost of available materials; and secondly, the ability to store the captured energy effectively for times of inclement weather. Her group's research aims to produce a solar-driven system that will both collect solar energy and provide electricity while saving it as a fuel in the form of hydrogen. The system that Professor Diale and her colleagues are hoping to introduce is a device that uses solar energy entirely to power all forms of household and industrial uses.

South Africa occupies a position on the world solar map that allows the country access to 4.5 to 6.5 kWh/m² of solar power per day at 2 500 sunshine hours per year. This is in stark contrast to Germany,



PhD student Kelebogile D Maabong, with Rita Toth, Artur Braun, Jianjun Wang and Debajeet K Bora from Empa.

a country that is at the forefront of solar power and a world leader in PV installation, yet receives on average only 3.3 sunshine hours per day. South Africa's geographic position means that solar energy must be considered as a viable solution to the energy challenges that face the country, and in particular for communities in rural areas and informal settlements. As most of the data in solar energy systems and technologies still come from developed countries, Professor Diale's goal, and that of her group and collaborators, is to generate South African solar energy collection devices, and data sheets.

Supported by National Research Foundation (NRF), Professor Diale and her team also collaborate with Dr Onesmus Munyati at the University of Zambia, in developing flexible all-polymer solar cells that can be used as roof-top paint. Metal nanoparticles are embedded in the paint to improve light harvesting. Further collaboration with the University of Dar Es Salaam, led by Dr Margaret Samiji, has enabled the team to produce zinc oxide nanorods, which are used in making solar cells, thereby reducing the cost with easy-to-make metal-oxides. Further collaboration with the Swiss Federal Laboratories for Material Science and Technology (Empa), Switzerland, has enabled her team to use rust (Fe₂O₃) as an electrode to directly convert solar energy to solar fuel, hydrogen.

In collaboration with Dr Artur Braun in Switzerland, Professor Diale's team is involved with the direct conversion of solar energy into solar fuels. Using a photoelectrochemical cell for water splitting, rust is used as a semiconductor to collect solar energy, producing electrons and holes in a solution, where water is oxidised to oxygen and hydrogen.



Mmantsae Diale

SMART GRIDS INTEGRATING RENEWABLE ENERGY

South Africa's national electrical grid system is under increasing strain due to its ageing infrastructure, insufficient maintenance, and a lack of real-time monitoring. Several research groups at UP's **Department of Electrical, Electronic and Computer Engineering (EECE)** are working with industry and government to address these challenges.



The intention to improve South Africa's energy sector is the driving force behind much of the work undertaken, often in partnership with the power utility, Eskom, the South African National Energy Development Institute (SANEDI), the Department of Energy, and the National Energy Regulator of South Africa (NERSA). Two areas of focus are presented here:

Professor Ramesh Bansal, Head of the Power Research Group in EECE, is working on flexible alternating current transmission systems (FACTS) for Eskom. The FACTS systems help to maintain voltage while transporting electrical energy over long distances. As an added benefit, his work on



Ramesh Bansal and
Raj Naidoo

improving renewable and hybrid energy systems are key for rural communities, many of whom are still without a reliable connection to the national grid. A related aspect of his group's research focuses on how best to integrate renewable energy sources into conventional power systems. The integration of renewable energy generators in distribution networks increases the complexity of voltage control, thus rendering traditional control methods ineffective.

Another research group, led by **Professor Raj Naidoo**, and working with SANEDI, has taken a multi-pronged approach to strengthening the electricity sector. They are developing smart metering technology for municipalities, and revising the technical standards for integrating smart grids and devices into the larger network (known as grid codes). At the same time, they are also working on the development of smart grid data security. The integration of this new technology affects not only the national electricity system, but would provide accurate information on the state of the grid, thus making possible the real-time monitoring of the national electrical grid system.



Article adapted from *Research Matters*; see <http://www.researchmatters.up.ac.za/researcher-projects/view/22>

LIGHT-HARVESTING OUTSMARTING NATURE

"The more I understand physics, the more I become fascinated by life processes – the detail, the remarkable efficiency, robustness, variety and elegance."

This is how **Dr Tjaart Krüger** in the **Department of Physics** at UP introduces his research in the field of molecular biophysics, a field that lies at the confluence of several scientific disciplines: physics, biology, chemistry, computer modelling and software engineering.

The natural environment is a rich source of adaptation, innovation and inspiration for numerous technologies, including solar technologies. Photosynthetic organisms convert solar energy into 'fuels' with an extraordinary efficiency and adaptability, that have yet to be applied in even the most advanced human-engineered energy technologies.

Dr Krüger's research is focused on the primary processes of photosynthesis, where solar photons are absorbed by and transported within light-harvesting complexes (called 'nano-antennae') and converted into transmembrane electron and proton gradients with an efficiency of close to 100%. However, because photosynthetic organisms have not been optimised for the production of fuels, there are significant energy losses that occur during the processes of energy storage and stabilisation. There is therefore much room available to engineer solar cells that outperform the natural systems.

Recent developments in molecular biology, as well as imaging and spectroscopy techniques, have pushed understanding of photosynthesis to the level where it allows, for the first time, considering the idea of redesigning photosynthesis and creating an artificial photosynthetic apparatus. The great advantage of such an artificial system would be that it could be adapted to specific circumstances. This approach holds great promise for advancing energy and agricultural technologies, in particular.

To guide this ambitious objective, it is important first to characterise natural photosynthetic systems in



great detail, and to decide which natural features need to be replicated in artificial photosystems in order to outperform natural structures. This is where biophysics comes into the picture, and Dr Krüger published, in 2016, a major review article in which he addressed some of these ideas.

Light-harvesting antennae, which consist of protein super-complexes that bind dense arrangements of pigment molecules, are some of the most complex molecular systems in the universe. But Dr Krüger's research team is now at a stage where they are starting to understand many of the fundamental principles of these exceedingly complex systems. His approach is to develop and use advanced spectroscopy techniques to investigate the primary processes of photosynthesis. The two main techniques are single-molecule spectroscopy and ultrafast spectroscopy: methods that enable him to perform spectroscopy on individual molecules and at timescales as short as a few femtoseconds (i.e. 10⁻¹⁵ s). They are also developing ways to control various aspects of light-harvesting, using light, chemicals and nanostructures. Some of these complex experiments were reported in 2016 in the *Journal of the American Chemical Society*.

Dr Krüger's research links a network of international collaborators in France, the Netherlands, England, Lithuania, Russia and Czech Republic, and includes one of the 2014 Nobel Laureates in Chemistry.

Asmita Singh, Tjaart
Krüger and Alexander
Paradzah



Tjaart Krüger



HUMAN RIGHTS

This theme groups research related to human rights and the law, from the interaction between research, advocacy and the use of courts to protect children, to international law on armed conflict and human rights, migration and forced displacement, as well as constitution-building in Africa. UP houses several strong legal research entities, with three featured here – the Centre for Child Law, the Centre for Human Rights, and the Institute for International and Comparative Law in Africa, each with a distinct contribution to the theme on human rights. Texts on a documentary film and exhibition, as well as a theatre performance, add further dimensions to understanding our ‘apartheid afterlives’ and rights.

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THE RIGHTS OF CHILDREN

RESEARCH, ADVOCACY AND LITIGATION

Using the courts to promote the rights of children involves research to inform court cases and submissions, and further, to ensure that writing about children's rights litigation becomes a published record for future reference.

South Africa's Constitution is recognised internationally for promoting and protecting children's rights in section 28 of the Bill of Rights. Courts interpret the rights in the Constitution within a framework of international and regional law, which means that there is a comparative consideration of the law of other countries, too. This, in turn, means that good research to support a child rights argument in court is invariably done through global partnerships.

The Centre for Child Law based in UP's Faculty of Law has earned a reputation for well-researched submissions that have been argued by the Centre's legal teams before the Constitutional Court. Professor Ann Skelton, Director of the Centre, writes that this was achieved through in-house research, but also through international cooperation, in 2016, with student researchers at the Oxford Human Rights Hub, United Kingdom. For example, the case of Zephany Nurse came to court in 2015. Zephany had been kidnapped



shortly after birth almost 18 years before. She was 'found' three months before her 18th birthday, and was living with a different name and identity. Represented by Ann Skelton, she fought to have her identity protected beyond the age of 18 years.

The Centre continues to ensure that this protection is afforded to other children who were victims, witnesses or offenders and who have turned 18, through a second part of the case launched in 2016 that seeks to have the law interpreted in line with the Constitution, or alternatively, to declare it invalid. In this instance, the Oxford Human Rights Hub team undertook comparative research on how this type of case has been dealt with elsewhere in the world, while the Centre for Child Law researchers and the legal team drafted a detailed set of papers on the factual and legal situation in South Africa, and on international and constitutional law.

Another example of foreign law feeding into a constitutional court case in 2016 was a case about surrogate motherhood. The Children's Act requires that one of the commissioning parents must be genetically related to the child who is to be born. In *AB v Minister for Social Development*, this aspect of law was challenged by a widow who had no viable gametes. In written and oral *amicus curiae* (friend of the court) submissions presented by the Centre's Deputy Director, Karabo Ozah, the Centre for Child Law argued that the law was reasonable and justifiable because it protects the right of the child to know his or her origin. The majority of the Constitutional Court ruled in favour of that argument.

Writing about children's rights litigation has involved the Centre's staff in investigating how case law is in line with international law, such as the UN Convention on the Rights of the Child, and the regional instrument, the African Charter on the Rights and Welfare of the Child. The recognition of South African child rights jurisprudence as a leading example in the world has been reflected in several published articles and chapters in books by the staff of the Centre for Child Law.

INTERNATIONAL RECOGNITION

In June 2016, Professor Ann Skelton was elected to the United Nations Committee on the Rights of Children, an 18-member committee made up of independent experts from around the world. Her five-year term will be from 2017–2021.

Professor Skelton's election to the UN Committee was followed by further recognition of her work in December 2016 when she received the Juvenile Justice without Borders International Award. This international award acknowledges her work over the past 20 years in promoting children's rights and helping improve the juvenile justice system in South Africa.



Ann Skelton and Karabo Ozah



BARRIERS TO JUSTICE CHILDREN WITH SEVERE COMMUNICATION DISABILITY

Children in South Africa face multiple environmental risks, including poverty and its many ramifications, family and community violence, and poor access to basic services related to health, education and justice.

The Centre for Augmentative and Alternative Communication (CAAC) in the Faculty of Humanities runs a multipronged research project aimed at understanding and addressing some of the risks children face, particularly children with severe communication disabilities.

In 2016, a study was conducted as a first step in developing a descriptive tool to measure trauma in young South African children, with support from postgraduate students in the Master's in Early Childhood Intervention programme. Building on



The research project forms part of the Mellon-funded Faculty Research Theme in the Humanities, *Enhancing the wellbeing of vulnerable children* (2014–2016). Staff involved are: Professor Juan Bornman, Professor Shakila Dada, Dr Kerstin Tönsing, Dr Alecia Samuels, Dr Ensa Johnson, Refilwe Morwane, Robyn White, Karin van Niekerk, and Enid Moolman.

earlier work, the aim of the 2016 study was to identify barriers experienced by children with severe communication disabilities in accessing the criminal justice system. This was done through a series of in-depth interviews and focus groups with professionals who work in the justice system, followed by a second part that focussed on the factors that could assist children with communication disabilities who have been victims of crime to access the South African criminal justice system.

Based on the findings, a disability sensitivity training programme for police officers was developed. The first phase of this project also included a systematic review of existing programmes, and a pilot study to test the effectiveness of the programme that had been developed. In the review of existing programmes, it was found that very few training programmes have been published and are open to external peer-review scrutiny, and that only in a few cases has their effectiveness been measured. This illustrates the importance of empirically-based tested police training programmes to equip police officers in effectively serving persons with disabilities, and especially children with communication disabilities, in an equitable and appropriate manner.

This project has been expanded to develop a three-phase court victim empowerment programme that can assist a victim with a communication disability, the victim's family and the legal professionals during the court preparation process, while testifying in court, and during the post-trial debriefing and counselling procedure.

The second intervention in 2016 focused on the development of a sexuality training programme for young women with intellectual disabilities, in an attempt to empower them and prevent victimisation and sexual abuse. This is an area often neglected in intervention, due to the cumulative effects of negative social attitudes to the sexuality of women with intellectual disabilities, as well as the restrictive social perspectives of the sexuality of women in general. This project was based on the PhD work of Dr L Rathbone who graduated in 2016.

UN MANUAL ON INVESTIGATING VIOLATIONS OF THE RIGHT TO LIFE

The Minnesota Protocol on the Investigation of Potentially Unlawful Death, completed in 2016, is the global standard used by medical doctors worldwide when they conduct autopsies, by police officers in homicide investigations, and by courts and commissions of inquiry into unlawful deaths and enforced disappearances.

Under the auspices of the United Nations (UN) Office of the High Commissioner for Human Rights in Geneva, the Minnesota Protocol, first published in 1991, was revised over a three-year period by a team of 73 experts worldwide. A number are staff members associated with the University of Pretoria. The project was led by **Christof Heyns, Professor of Human Rights Law** in the Faculty of Law, who served as UN Special Rapporteur on extrajudicial, summary and arbitrary executions 2010–2016, and is the Director of the Institute for International and Comparative Law in Africa (ICLA). The chief research coordinator was Dr Stuart Maslen from Geneva, a ballistics and international law expert and honorary professor in the Faculty of Law, assisted, among others, by Dr Thomas Probert from Cambridge, who is also a senior researcher in the Faculty. **Professor Gert Saayman, Head of the Department of Forensic Medicine** in the Faculty of Health Sciences, as well as **Professor Pieter Carstens**, who teaches Medical Law in the Law Faculty, served on the Advisory Panel.

Professor Heyns has for the past six years conducted investigations for the UN into unlawful killings in ten countries, including in Papua New Guinea, India, Gambia and Burundi. He identified the need to update the Protocol during these investigations, and some of the new features are aimed at



Christof Heyns

addressing shortcomings encountered during these investigations. He writes that one of the key ways of ensuring that life is protected is to have thorough investigations every time it appears that there has been an unlawful taking of life.

The Protocol contains a set of detailed guidelines on crime-scene investigation, interviews, the excavation of graves, autopsy, the analysis of skeletal remains, and the assessment of the impact of armed conflict. The document will be available in the six United Nations languages, and will be launched in New York, Toronto, Buenos Aires, Bangkok and other parts of the world in 2017.

The new Minnesota Protocol was welcomed by the UN High Commissioner for Human Rights, Zeid bin Ra'ad Hussein, who said: "A suspicious death occurring anywhere in the world is potentially a violation of the right to life, often described as the supreme human right, and prompt, impartial and effective investigations are key to ensuring that a culture of accountability – rather than impunity – prevails. The same applies to enforced disappearances. The new Minnesota Protocol provides a comprehensive and shared platform for forensic investigators, pathologists, law enforcement officials, lawyers, prosecutors, presiding officers, and NGOs to make accountability a worldwide reality. I am grateful to the former Special Rapporteur, Christof Heyns, for the hard work, the rigour and the excellence that has gone into this vital and timely revision."

ARMED DRONES AND INTERNATIONAL LAW

Armed drones have emerged over the past decade and more as the new ‘revolution in military affairs’. Great controversy has arisen about their use, including the legality of the remote use of force. Thousands of people – including a large number of civilians – have been killed in countries such as Afghanistan, Pakistan, Yemen and Somalia by missiles launched by remote control, often from halfway around the world, from these so-called ‘unmanned aerial vehicles’.

Christof Heyns, Professor of Human Rights Law in the Faculty of Law at UP, is one of the leading authorities worldwide on armed drones and the law. In an article that appeared in the Cambridge University Press flagship publication, the *International and Comparative Law Quarterly* (ICLQ), he sets out his views on the topic.¹ Dapo Akande, Professor of Public International Law at Oxford University, was one of the co-authors. The article won the Paper of the Year award with an invitation by the editorial board of the journal to the authors to deliver the ICLQ Annual Lecture on the topic of their article at Cambridge University in 2017.²

Heyns’s work on drones started when he was appointed as United Nations Special Rapporteur on extrajudicial, summary or arbitrary executions in 2010. In 2014 he presented an influential report on drones to the UN Human Rights Council in Geneva and, in preparation, convened a meeting of 20 experts at Oxford University earlier that year. This is

where his collaboration with Professor Akande started.

The main message of Heyns’s work is clear: drones are not unlawful weapons as such, but it is the ease with which they can be used by states to project lethal force worldwide that is cause for great circumspection and a stringent application of the legal rules applicable to their

use. As Heyns puts it: “Drones should follow the law, not the other way around”. He writes that drones allow states to eliminate those whom they consider to present a threat to them at little or no risk to their own forces. In such contexts, there is a tendency to interpret the legal rules applicable to the use of force in ways that facilitate their use. Therefore the need to set out those rules in as clear and comprehensive a way as possible, so as to ensure that they are not watered down.

There are several legal regimes applicable to the use of force by states, and stringent restrictions on when one state may use force in the territory of another state. In addition to the rules that protect the sovereignty and territory of states, separate legal regimes aimed at the protection of people place further constraints on the use of force. In a situation of war, the rules of the law of armed conflict are the primary points of reference, while human rights law alone determines when force may be used in all other situations.

According to Heyns, the rules of the law of armed conflict are much more permissive about the use of force than human rights law. As a result, states often



claim that armed drones are used in situations of war, even if the situation at hand does not objectively qualify as an armed conflict.

He notes that, in the long run, it is in the interest of everyone to stick to the established rules. More and more states are acquiring drones, and if states who used them first, such as the United States of America, bend the rules to suit themselves in the short term, they create precedents which will come back to haunt all of us and undermine global security.

ARMED DRONES AND POLICING

Armed drones are increasingly also used in domestic policing, for example in crowd control. Professor Heyns, in a 2016 article in the *Human Rights Quarterly*, says that we need to be even more circumspect about this development: the primary duty of the police is to protect people. If they are not present at the scenes where their presence is required, they cannot do so. There are no legal grounds to say that armed drones are under all circumstances unlawful weapons of law enforcement and therefore should be banned, but the existing human rights rules, such as those of necessity, proportionality and precaution, should be applied with great rigour.

The challenge will remain to ensure that short-term advantages do not take us on a road where we do not want to be in the long run.



Dapo Akande and Christof Heyns

¹ Heyns C, Akande D, Hill-Cawthorne L and Chengeta T, 2016. The International Law Framework Regulating the Use of Armed Drones. *International and Comparative Law Quarterly* (ICLQ), 65, 791–827.

² The *International and Comparative Law Quarterly* analytics show that the paper already falls within the top 5% of all research outputs scored.

PROMISES AND LIES

The business of the past is far from over, and scripts everyday lives in all kinds of ways.



This is the central premise of a combined documentary and exhibition, *Promises and Lies: Fault Lines of the ANC* directed and produced by **Dr Siona O'Connell**. Stemming from O'Connell's research in 2016, the 35-minute documentary pivots on a set of previously unreleased photographs taken by award-winning British photographer, Laurie Sparham. O'Connell was particularly interested in the years when these photographs were taken: 1989–1991 marked a world in transition, with revolutions in the Eastern Bloc, the fall of the Berlin Wall, and in South Africa, the dismantling of apartheid. Events critical to the latter transition – from white minority rule to multiracial democracy – included the unbanning of organisations like the African National Congress (ANC) and the Pan African Congress (PAC), the return of political exiles, the release of Nelson Mandela and other political prisoners, and the initiation of

Siona O'Connell is an academic, curator and filmmaker at the University of Pretoria. Her other research themes are land reform and the local clothing and textile industry. She has produced and directed five documentaries.

political negotiations in the country. It is against this background of groundbreaking shifts that O'Connell conceptualised the project, making the argument that the business of the past is far from over and continues to script our lives.

Both documentary and exhibition intentionally provide entry points into conversations about the memory of promises and hope, and life in South Africa after apartheid – with hindsight, can we see the fault lines now?

As with the rest of her work and personal interest, O'Connell is interested in 'apartheid afterlives', which she investigates through the frames of archive, memory and freedom. The film and accompanying exhibition, hosted by VIAD at the University of Johannesburg, offer viewers a chance to consider the personal and familial sacrifices of political exile, the promise of freedom that was its aspiration, and these in relation to a current landscape of crisis and failure in which we, as 'new South Africans', find ourselves complicit. The film includes archival footage and interviews with key commentators including Trevor Manuel, Professor Pierre de Vos, Robert McBride and Ivan Pillay.



Inauguration of President Nelson Mandela, Union Buildings, Pretoria, 1994.

Paul Weinberg

MAMA MUDU'S CHILDREN UBUNTU IN CONTEMPORARY SOCIETY

The Ubuntu project at UP has several research foci clustered around four themes. The primary focus is the concept of Ubuntu and inserting this into the broad intellectual debate on self and community, by demonstrating its intellectual and philosophical value and practical grounding in practices emanating from the Africa continent.

There were several research outcomes and notable events in 2016 for the Ubuntu project as a whole. A significant highlight was the production of *Mama Mudu's Children*, a play written and directed by playwright **Dr Masitha Moeane**, and supported by **UP Arts**. The play is rooted in aspects of the broader Ubuntu research findings and fieldwork experiences, especially related to interrogating the value and relevance of the concept Ubuntu in conflict and post-conflict situations in contemporary society. It is set in an imaginary community, Edladleni, in post-freedom South Africa, and captures a community that swims against the tide of survival and a myriad thwarted expectations. Characters embody a battle with the slide from deprivation to depravation: xenophobia, crime, family units disintegrating, alienation, negativity, and bitterness. Yet, even in the depths of despair, redemption remains possible in people's resort to Ubuntu – as captured in human values, community spirit and environmental activism.

The script was finalised with contributions from **Professor James Ogude**, Director of the **Centre for the Advancement of Scholarship** at UP, and award-winning playwright and leading scholar in African Drama and Cinema, **Professor Bhekizizwe Peterson** of the University of the Witwatersrand. In rehearsals, Dr Moeane worked closely with a full cast of UP students, some of whom had never performed on stage before, together with **Mxolisi Duda** (Deputy Director of the production), and **Phuti Matuba** (technical manager), to stage a gripping African theatre performance.

The first performance at the Aula theatre at UP was a resounding success, played to a capacity audience, with further

performances in 2017. When the play was performed to a Soweto Theatre audience, several audience members expressed their appreciation for the significance of the play in contemporary South Africa. The play is an example of participatory theatre in Africa, especially in its use of language, song and dance, myth and magic, belief systems and in its general texture. Its aspiration is simple: to tell an interesting, original story that is socially and humanly significant, and to tell it well. The play has been recorded on DVD and translated into Sesotho. Both English and Sesotho versions are in press, due to be published by African Perspectives. Professor Ogude is also consulting with leading Swahili scholars to have the play translated into Swahili.



THE FUTURE OF DEMOCRACY

“From the 1990s to the present day, Africa has had a fervour for crafting and re-crafting constitutions. The emphasis has been on constitutionalism, good governance and the rule of law, all of which raised high hopes that the era of repressive, arbitrary and autocratic rule is over [...] They contained a catalogue of human rights, and placed constraints on governments to promote, inter alia, democracy, transparency, accountability and service delivery. Many also had provisions limiting presidential terms to ensure alternation of powers. However, as we move towards the end of the third decade since the winds of change of the 1990s, the reality is that few of those original hopes have been met.”¹

Professor Charles Manga Fombad heads the African Constitutional Law Unit at the Institute for International and Comparative Law in Africa (ICLA) in the Faculty of Law at UP. He has also leads two research projects that attained significant milestones in 2016. The first is on constitution-building in Africa, which is based on an annual seminar series jointly organised by ICLA and the Stellenbosch Institute for Advanced Study (STIAS), under the broad theme ‘the future of democracy’. An important outcome of the seminar series has been the publication of the first volume in a new series: *Stellenbosch Handbooks in African Constitutional Law Vol 1: Separation of Powers in African Constitutionalism* (Charles Fombad ed., OUP, 2016).

The overriding objective of the project is to contribute, through research, to promoting and deepening constitutionalism in Africa. The seminars

have focused on several aspects of comparative constitutional law research in Africa, to provide in-depth knowledge and understanding of African constitutional regimes and their evolution. The first book in the new series, *Separation of Powers in African Constitutionalism*, presents the contributions of a wide network of scholars, researchers and legal activists. Examining one of the key measures introduced by African constitutional designers to entrench an ethos of constitutionalism on the continent, the publication takes a critical look at the different attempts to separate the different branches of government, and the impact of this on transparent and accountable governance.



This first volume signals to the world that comparative constitutional law issues in Africa are important. It also lays an important foundation for closing ‘a gaping knowledge gap’ with respect to comparative constitutional law research in Africa, as well as in the analyses of challenges faced in African constitution-making processes, and in the implementation of African constitutions.

In recognition of what this series brings to scholarship in comparative constitutional law, Professor Fombad was invited by the University of Melbourne and the International Association of Constitutional Law (IACL) to launch the first book in the series, in Melbourne. Manuscripts of the second book in the series are already with Oxford University Press (OUP), with the book scheduled for publication in 2017.

The second project involves introductory reports on the constitutions of all African countries. These are also published by OUP, as part of the *Oxford Constitutions of the Countries of the World Online Series*. Since 2011, ICLA, in partnership with the Max Planck Institute (MPI) for Comparative Public Law and International Law (Heidelberg, Germany), has coordinated the Africa country reports for the Oxford Constitutions Online. Professor Fombad is co-editor of the Africa country reports, working closely with Prof Dr Rainer Grote, senior research fellow at the MPI. By the end of 2016, the introductory reports of 24 of the 54 African countries had been published. Under a special agreement between OUP and ICLA, all the published introductory reports on African countries, as well as the latest version of the constitutions of the relevant countries, are published on the ICLA website², and are accessible and frequently consulted by researchers free of charge.

¹ Charles Fombad (ed.), 2016. *The implementation of modern African constitutions: Challenges and prospects* (PULP, Pretoria).

² ICLA website: icla.up.ac.za/oxford-constitutions/constitutions

MIGRATION

AFRICA, THE CONTINENT MOST AFFECTED

Migration, especially of Africans and people from the Middle East attempting to cross the Mediterranean Sea into Europe, has received widespread media coverage in the past few years.

The common narrative is that migrants, the majority of whom are young people of working age, are escaping poverty in their countries of origin for a better life in Europe. But the drivers and factors that motivate people to migrate may actually be more complex.

Dr Christopher Changwe Nshimbi, DST-NRF Research Fellow and Deputy Director of the Centre for the Study of Governance Innovation (GovInn) in the Department of Political Sciences, has teamed up with researchers at the Institute for Peace and Security Studies (IPSS) of the Addis Ababa University, Ethiopia and of the University of the Sahel, Senegal. Their three-year research project covers the major regions of Africa, in the North, the Sahel, West, South, and the Horn of Africa, and is generating perspectives and data on migration from affected communities. Key questions include identifying what constitutes the source, and what are the transit routes and destinations within and out of the continent, in order to inform long-term approaches to addressing migration.

Despite the publicity around large-scale migrations of Africans to Europe, Africa remains the continent most affected by migration and forced displacement: it deals with higher numbers of migrants, refugees and internally displaced persons (IDPs) than other regions, because high levels of migration occur within the continent.

Related to this large-scale project, Dr Nshimbi is also conducting research into the little understood but largely criminalised phenomena of undocumented migration and informal cross-border trade. In June 2015, the member states of the Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC) and the Southern African Development Community (SADC) established the COMESA-EAC-SADC tripartite free trade area (TFTA),



to enhance the integration of these regions and the respective 26 countries of the TFTA. In view of this, Dr Nshimbi's project, spanning a five-year period, investigates the activities of informal cross-border traders and migrants. Informal (ethnic) entrepreneurs, local non-state actors, relevant officials from local, provincial and national governments, as well as relevant officials from COMESA, EAC and SADC inform the research while special attention is paid to persons living in the borderlands of the countries that form the tripartite region.

Dr Nshimbi has also, since July 2016, been part of an international Human Rights Impact Assessment (HRIA) project team, commissioned by the Office of the High Commissioner for Human Rights (OHCHR) of the United Nations, the United Nations Economic Commission for Africa (ECA), and the Friedrich-Ebert-Stiftung (FES, Geneva), to undertake an impact assessment of the African Union's planned continental free trade area (CFTA). Dr Nshimbi is responsible for the case study on informal cross-border traders. The full report is due for release in mid-2017.



Suzy Bernstein (<http://www.picturenet.co.za/>)

CONSTRUCTS OF TRANSGENDER AND THE SCIENCE OF OUR TIMES

“There is a growing commitment in public health to understand and improve the health and wellbeing of transgender people and other gender minorities, who comprise an estimated 0.3–0.5% (25 million) of the global population. The adoption of the 2030 agenda for sustainable development and its pledge to ‘leave no one behind’ has given renewed impetus to this movement.”¹

Transgenderism is a prominent socio-medical entity that has attracted wide media, social and medical discussion. The University of Pretoria **Gender Reassignment Clinic** at the Steve Biko Academic Hospital was started in 1992 and formalised in 1994, with team members representing the Departments of Gynaecology, Psychiatry, the Internal Medicine Division of Endocrinology, Urology, Plastic Surgery and the Institute for Molecular and Cellular Medicine.

Professor Gerhard Lindeque, Head of **Obstetrics and Gynaecology**, writes that transgenderism is not a psychiatric disease, as is commonly held. It can best be described as a disconnect of the assigned gender based on the physical form, and the self-realisation of gender as being what the person sees his or her gender to be. Several interventions are required to manage and support transgender individuals, and to decrease mortality.

Transgender people typically have low rates of access to health services due to a range of issues, including violence, legal barriers, severe stigmatisation and discrimination. In South Africa, the exact prevalence is unknown as many keep their condition hidden, and

underdiagnosis is common. If untreated, the mortality of transgender people is high as a result of suicide.

Individuals are most commonly referred to the UP Clinic by a psychiatrist or psychologist, and are met by a multidisciplinary team. Once accepted into the Clinic, the time-spaced sequence of gender reassignment includes a psychiatric evaluation to exclude psychiatric disorders; a programme to provide a continuum of support; endocrine support and hormone treatment; and finally, surgical interventions which result in the desired physical gender. There are multiple exist points which are determined by the individuals themselves based on the extent of the interventions desired.

Professor Michael Pepper, Director of the **Institute for Cellular and Molecular Medicine**, writes that the interplay between nature (genes and genetics) and nurture (the environment) is at the heart of the debate about the factors responsible for gender and sexual diversity. While transgender identities have existed through much of recorded history, it is only in the past 50 years that the term *transgender* has been used. And it is only more recently that science, at a molecular level, has suggested that environmentally-induced variations in the expression of an individual’s genes (epigenetics) before birth, can lead to variations from perceived societal normality.

Despite advances in science, and the rights enshrined in the highest levels of the law both in South Africa and internationally, gender and sexual variation have led to immense suffering for lesbian, gay, bisexual, transgender and intersex (LGBTI) people because they do not fit the expectations of what is considered by certain sectors in society to be the ‘norm’.

CHILDREN AND SCHOOLING HISTORY EDUCATION IN DIVIDED AND POST-WAR SOCIETIES

Teaching history in schools is often a sensitive and contested matter, particularly in divided and post-war societies where the past typically remains at the heart of intergroup conflict. In such contexts, dealing with the past is both a challenge and an opportunity for intergroup reconciliation processes.

Dr Denise Bentravato, a postdoctoral research fellow in the **Department of Humanities Education** at UP, has shed further light on the distinct role of history education in contexts of conflict and peace. Her research builds on the premise that teaching history can play both a negative role by exacerbating division, and a positive role by helping divided societies heal wounds and reconcile. Based on this premise, her work aims to provide insights into approaches adopted in schools to teach about violent pasts, the challenges and opportunities involved, and the implications of current practices for peace-building.

In 2016, her research culminated in the publication, *History can bite: History education in divided and postwar societies* (Eckert. Die Schriftenreihe), a book co-edited with Karina Korostelina and Martina Schulze, with 15 contributions on cases from around the world, including an own chapter that examines the experiences of teaching contested histories in Rwanda and Burundi.

Key findings of this collaborative work can be summarised as follows: The volume illustrates the role of history education as a tool for nation-building, and as a mechanism of societal inclusion and exclusion and a (potential) source of conflict. The book sheds light on the widespread cultures of silence promoted through schools around the world in the aftermath of violence, to the effect of depriving younger generations of a chance to make sense of their country’s history and the legacies of the past. The examination of everyday classroom practices demonstrates the key role of teachers in enacting curricula and textbooks, and again calls attention to the pervasive silence and discomfort found in many classrooms in postwar societies. Importantly, the research reveals the large failure of schools to function as safe spaces for open dialogue and critical inquiry, and reflection on the past and the present in postwar societies, and warns against the threats to social cohesion and stability posed by this failure.

Together with Johan Wasserman, Professor of Humanities Education in the Faculty of Education, Denise Bentravato is the co-founder and co-director of the African Association for History Education (AAHE-Afrika), a non-profit organisation located in the Faculty of Education at UP.



Guy Stubbs, Africa Media Online

WHAT CHILDREN ARE TELLING US

South Africa is one of the most violent countries in the world, and it is therefore perhaps unsurprising that there seems to be an increased incidence of violence at schools.

Drs Miemsie Steyn and **Melanie Moen** in the **Department of Early Childhood** in the **Faculty of Education** at UP undertook a study of young children, aged between six and nine years, to identify dominant themes that prevail in children’s experiences in the early school years. The study included 224 children from 30 private and government schools in Gauteng, which were randomly selected to participate in the study.

Teachers were asked to get learners to draw pictures of ‘things that make them sad’. Since young children are often unable to express their emotions adequately, drawing provides a safe way for revealing emotions that they cannot (or do not want to) express in words. Teachers discussed the drawings with the children to ensure that they interpreted the drawings correctly. Although the participating schools varied greatly with respect to the profile of children, two themes dominated: that of violence and of loss.

The key findings emphasise the importance of addressing the issues of violence and loss in the teacher training curricula at institutions of higher education. They stress that it is imperative that student teachers be made aware of the factors that affect children’s emotional wellbeing, while simultaneously equipping them with the skills and knowledge needed to support children in dealing with adversities before problems escalate and psychological damage becomes difficult to reverse.

As a result of the outcomes of this study, UP’s Faculty of Education has incorporated specific sections in the Life Skills curriculum on addressing the issues of violence and loss; it also plans to develop training material for other universities in South Africa.

¹ R Thomas *et al.* Ensuring an inclusive global health agenda for transgender people. *Bulletin of the World Health Organisation* 2017; 95:154–156. doi: <http://dx.doi.org/10.2471/BLT.16.183913>

HUMAN RIGHTS BEYOND THE RHETORIC

The **Centre for Human Rights** in 2016 focused on applied research, by drawing attention to issues of great concern to our continent, and importantly too, to the actual implementation of human rights standards in African countries. Three areas are chosen to illustrate some of the work of the Centre.

The **Centre's Disability Rights Unit** hosted a conference in November 2016 under the theme, *Advancing the Rights of Persons with Albinism in Africa: A Call for Action*. Papers highlighted the severe nature of the stigma and discrimination faced by persons with albinism in many parts of Africa, including extreme acts of violence. More importantly, the conference also aimed to develop responses to these human rights violations, and hosted a high-level meeting, involving the United Nations Independent Expert on the Human Rights of Persons with Albinism. The outcomes included a draft Regional Action Plan to address rights abuses against persons with albinism, and key resolutions taken to direct implementation.



Ikponwosa Ero, United Nations Independent Expert.

The **Gender Unit** has been involved in number of initiatives to end violence against women and girls, and to eliminate harmful practices that women and girls have to endure. A *Harmful Traditional Practices* tool, for use by practitioners working to end child marriage and female genital mutilation through advocacy and litigation, was finalised in 2016. This tool was produced in partnership with Equality Now and the Solidarity for African Women's Rights (SOAWR) network. The Gender Unit also carried out research on child marriages in 10 countries in Africa to inform the elimination of child marriages, and completed the research report in 2016. The report highlights the problem of child marriages, its prevalence and impact on young girls, and discusses the policy and legal frameworks governing child marriages. It also makes concrete recommendations for ending child marriages, drawing on states' obligations under the Maputo Protocol and the African Charter on the Rights and Welfare of the Child (African Children's Charter), both of which stipulate the minimum age of marriage to be 18 years without exception. Following the report on child marriages, two regional and one national community dialogues on child marriages were conducted, bringing together a variety of stakeholders, and sharing the findings of the research with the countries that had participated in the research. The dialogues also provided an opportunity to develop concrete national actions to end child marriages.

The third area that illustrates the work of the Centre is its focus on the implementation of human rights and human rights norms, rather than merely their articulation. In this domain, the Centre participates in a major research project, the *Human Rights Law Implementation Project* (HRLIP), a collaborative project between four leading academic human rights Centres (Bristol, Essex, Middlesex and Pretoria) and the Open Society Justice Initiative. The aim of the project is to examine the factors that impact on human rights law implementation by nine states across Europe, Africa and the Americas. It looks at selected decisions deriving from individual complaints to UN treaty bodies and selected judgments and decisions of the bodies in the three regional human rights systems.

The Centre takes responsibility for the study in Africa. The focus is on examining the utility and relevance of human rights law in the 21st century, an issue that is of concern to state actors (governments, legislatures and judiciaries), civil society actors, human rights bodies, and victims (and potential victims) of human rights violations.

In 2016 the Centre continued to follow up on cases decided by various African Union human rights bodies, in particular the case of *Shumba v Zimbabwe*. In a landmark decision in 2013, the African Commission on Human and People's Rights found the government of Zimbabwe in violation of the African Charter and ordered it to carry out an investigation of those responsible, and to pay Gabriel Shumba adequate compensation. To date, none of the recommendations have been implemented. The Centre's **Human Rights Implementation Unit** has embarked on an advocacy campaign aimed at applying pressure on African governments to comply with the decisions of the African Commission on Human and People's Rights.

Graduates of the Centre's academic programmes have collaborated to undertake a study of the impact of the African Charter and the Maputo Protocol. This study resulted in a publication: Victor Oluwasina Ayeni (ed), 2016. *The impact of the African Charter and the Maputo Protocol in selected African states*, published by the Pretoria University Law Press (PULP).



CHR staff Yolanda Booyzen, Frans Viljoen, Norman Taku, Yusuf Sayaad and Jehoshaphat John Njau.



THE CENTRE FOR HUMAN RIGHTS TURNS 30

The year 2016 was a year of celebration, with the Centre for Human Rights and the African human rights system commemorating 30 years of existence.

Amid the dark days of apartheid, and the emergence of states of emergencies, the Centre was established in 1986 by a small group of visionary academics in the Faculty of Law at the University of Pretoria. In its first decade (1985–1996), the Centre and its staff played an important role in South Africa's constitutional developments. In the Centre's next decade (1997–2006), its focus became increasingly more pan-African, as captured in its three flagship programmes: the launch of the Master's programme in Human Rights and Democratisation in Africa; the publication of the *African Human Rights Law Journal*, first appearing in 2001; and the all-African participation of continental universities in the African Human Rights Moot Court Competition.

The Director at the time, **Professor Christof Heyns**, was instrumental in setting up many of these initiatives. The third decade (2007–2016) saw the Centre becoming an academic department in the Faculty of Law, and subsequently introducing a number of further academic programmes, including one for doctoral students; and extending its activities in pursuit of raising greater awareness and creating capacity to strengthen the African human rights system. **Professor Frans Viljoen**, the current Director of the Centre, has been at the helm since 2007.



HERITAGE AND SOCIETY

This theme ties together the links between antiquity and contemporary social issues, from the study of glass beads and ancient trade routes, to rethinking ancient forms of urban evolution, heritage conservation and the importance of preserving cultural heritage, to the analysis of the pathogen drivers of human mortality. Staying with issues of heritage and land, the 'invisible people' of the Tankwa-Karoo bring into focus a landscape and the people who have always lived there, in contrast to a distinctly different emphasis on fracking in the Karoo. The multidisciplinary focus of this theme is further extended to livestock keepers in two rural communities, the translation of a century-old text, and the 'drama of meaning', a text that again illuminates the work of a prolific writer in the late 19th and early 20th centuries.

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*Andries en Katriena met Nathan, Brieue uit die Tankwa
Adriaan Oosthuizen*

ANCIENT GLASS BEADS

MARKERS OF TRADE ROUTES

Glass beads have been produced and traded for millennia all over the world, and have been used as everyday articles of adornment, ritual and ceremony.

Indo-Pacific beads are found in considerable quantities throughout Southeast Asia and southern China, Korea, Japan, the Persian Gulf, India, and Sri Lanka. In fact, there is probably not a region in Asia that does not have them. As such they are significant markers of ancient trading networks, often synonymous with the Silk Route, a network of trade routes established during the Han Dynasty in China.

Although originally not manufactured in southern Africa, the preservations of glass beads in the archaeological record is good and large hoards have been found at excavation sites. Their shapes, sizes and colour, as well as the variety of composition and production technologies, motivated efforts to use them as markers of exchange pathways, from southern Asia through the Indian Ocean, to Africa. They are also excellent chronological indicators, and sequences dating these beads have been created, and continue to be refined.

Professor Innocent Pikirayi, and colleagues **Dr Farahnaz Koleini** and **Dr Xander Antonites** in the **Department of Anthropology and Archaeology**, have focused on beads recovered in southern Africa, at Mutamba in northern South Africa, and at Baranda, in northern Zimbabwe. Their research has been in collaboration with Dr Philippe Colomban (Pierre and Marie Curie University, France) and Dr Linda Prinsloo (University of Wollongong, Australia).

In 2016, portable X-ray fluorescence (pXRF) and Raman spectroscopy analyses of a representative sample of glass beads found at the two excavations were completed. These sites are linked to the intensification of and changing patterns in international networks of trade connected with the rise and development of complex socioeconomic systems in the regions since 1000 AD. Glass beads were predominantly used in trade exchanges for metals, pottery and animal products such as ivory.



The archaeological site of Mutamba.

Despite corrosion on the glass beads from Mutamba, compositional analyses of their trace elements, pigments, opacifiers, and colourants revealed a south and south-eastern Asian origin during the 13th and 14th century. Southern Africa would become an important part of the Silk Route, dominated in Asia by the Mongol Empire. The majority of the over 20 000 glass beads from Baranda, historically identified with the 16th–17th century trading market of Massapa, are of south Asian origin, which coincides with the Portuguese dominance of the Indian Ocean trade (1500–1650 AD).

The analyses will now be extended to other sites in the southern African region, and will also focus on imported ceramics such as porcelain and stoneware from Asia and Europe, in order more fully to understand trading networks associated with ancient and more recent trade routes.



GREAT ZIMBABWE

RETHINKING ANCIENT FORMS OF URBAN EVOLUTION

Great Zimbabwe, an ancient urban landscape, has remained a site of prolific research in archaeology and history, and more recently geoarchaeology and investigations into people-water interaction.

Innocent Pikirayi, Professor in Archaeology at UP, uses a combination of conventional archaeological research, written and oral texts, historical landscape characterisation, and settlement patterning and size, to understand the development and demise of Great Zimbabwe, and the civilisation it spawned in southern Africa since 1000 AD.

His research has involved collaboration with several universities working on different aspects of ancient urban settlements: the Great Zimbabwe University, the Universities of Aarhus in Denmark and Uppsala in Sweden, and the University of Cape Town.

Three recent research projects have focused on landscape histories around and beyond Great Zimbabwe, highlighting major issues in ancient urban settlement growth and the associated regional and global connections. Drawing on multidisciplinary frameworks, from archaeology and earth sciences, the quest is to understand one of the most complex societies in sub-Saharan Africa in the second millennium AD.

In 2016, the sampling of soil profiles to understand landscape changes, and the mapping of Great

Zimbabwe's water resources in the surrounding granite formations, were completed. These detailed surveys mapped landscape units, springs, farms and stream-beds, and collected soil samples for chemical analyses, micro-morphology, and chronometric dating. The studies also involved a re-examination of some of the major features around monumental ancient settlements.

New evidence suggests, for example, that 'earthen pits', previously thought to be exploited for the building of earthen structures, functioned as water reservoirs. Further, the soil sequences sampled from the Great Zimbabwe site reflect a complex history of water and soil management, indicating localised changes, rather than significant environmental shifts over time. Great Zimbabwe may not have declined as a consequence of major environmental disruptions.

The findings point to the possibility of a major reinterpretation of Great Zimbabwe that may have wide applicability in Africa and worldwide, particularly with respect to climate change and water management in ancient settlements, and also, what such findings suggest for present-day settlement planning and management.

Professor Pikirayi notes that a consideration of these ancient sites as comparable phenomena has the potential to transform the models used to understand settlement growth, and give new significance to regional culture histories that have implications for our urban future.



HERITAGE CONSERVATION

A JOURNEY OF DISCOVERY

Cultural heritage in all its tangible forms – from artworks to architecture, archaeology and museum collections – offers a link between the past, present and future. The continued visual presence of such forms of heritage is vital for a sense of history and place.

All structures and objects decay over time, and **Isabelle McGinn, Department of UP Arts and conservator at the UP Museums**, makes the point that there has been an increasing recognition worldwide that heritage conservation must be prioritised as a national and, in fact, moral obligation.

The University of Pretoria has an extensive collection of art, archaeology and museum collections.

Conservation at UP Museums is proactive, and includes large-scale preservation projects such as the *Lerapo Bone and Ivory Preservation Project* and the *Mapungubwe Gold Conservation Project*. Most recently, the Letsopa gallery in the Old Arts Building was the final step in the refurbishment of the permanent exhibition of the UP Ceramic collections (2011–2016). In this gallery, 116 low-fired ceramic vessels, spindle whorls and figurines have been placed on permanent exhibition, many for the first time.

Exhibition preparation is an interdisciplinary effort between exhibition designers, researchers, curators and conservators lending their expertise to the design of the new museum space; provenance and archival research into discovery and early

treatments; research and design of exhibition text; and, importantly, the conservation of the objects themselves. It is in the bringing together of different bodies of expertise, using macro- and microscopic examination and photography, as well as non-destructive analytical techniques, that a deeper understanding is gained of the material composition, manufacture and deterioration processes of these artefacts.

As portions of the collection on display form part of the National Estate, decision-making is necessarily influenced by the appropriateness of treatment, which includes considerations of past remedial treatments and means of preventing further deterioration, and extends to appropriate lighting design and the manufacture of displays and mounts.

In conservation projects, the requirements of each artefact are discussed between curator and conservator before treatment starts. Although conservation takes into consideration the aesthetics and visual aspects of the exhibition and individual artefacts, conservation is in the first instance guided by the principle of minimal intervention and stabilisation. Most treatments involve the removal of aged and unstable repairs, as well as previous overzealous over-painting to reveal the original surface of the artefacts. The physical structure of the vessels is then strengthened and consolidated by imbibing friable surfaces with dilute, 'sympathetic', and reversible adhesives.

From the viewpoint of a conservator, Isabelle McGinn writes that the most exhilarating part is the journey of discovery, or rediscovery, as cleaning reveals previously obscured details: a pot is pieced together from hundreds of shards, thus giving clues to its function; or residue analysis reveals its use beyond memory. Exposed under magnification and augmented examination using a variety of lighting conditions, fingerprints reveal how a potter held a lump of clay to shape a small hand-formed Mapungubwe vessel, colouration on a shard edge hints at firing temperatures, and technique and material composition of the clay pinpoints the locality from which it was extracted.

UP MUSEUMS

The University of Pretoria Museums managed by the Department of UP Arts curate 56 diverse art and heritage collections relating thematically to ceramics, sculpture and art. The permanent exhibitions comprise more than ten public galleries showcasing both ancient and contemporary ceramics, iconic archaeological gold, sculptural pieces and an array of artwork. These museum collections are on public display in the Old Arts building and the Old Merensky building, but many of the curated collections are exhibited across all eight campuses. The most renowned collections, such as the Mapungubwe gold collection, the eastern ceramics collection, and the landmark sculptural collections with over 40 works, are displayed across the UP Hatfield campus.

The Mapungubwe collection was one of the most iconic museum collections loaned from South Africa for the international exhibition titled, *South Africa: the art of a nation* held at the British Museum in London from 27 October 2016 until 26 February 2017. This was the first major UK exhibition on South African art that explored 100 000 years of history through archaeological historical and contemporary artworks and this was the first time in South African history that the Mapungubwe collection left South African borders. The original gold rhino, gold sceptre, gold vessel and two other gold animal figurines from the Mapungubwe Collection, as well as the Pierneef painting, *Wild Fig Tree* from the UP Art Collection, were highlight exhibits hand-selected by British Museum curators.

The museum staff conduct objects-based and curatorial research, manage permanent and host temporary exhibitions, and perform daily collections management and vital conservation of these rare and unique collections. The museum collections and associated documentation, such as the valuable archival collections, are available for research, teaching, training, exhibition and educational purposes, serving the purpose as both university museums as well as public museums.



Conservation work on a Mapungubwe clay pot.

FRACKING IN THE KAROO SEISMICITY-RELATED RISKS

There are many unanswered questions related to shale gas extraction in the Karoo as a potential new source of energy, one of which relates to the impact on seismicity.

The economic growth of any country is inherently linked to energy provisioning. With a growing economy, the demand for energy increases. This, in turn, stimulates the search for new sources of energy. The situation is no different for South Africa, where the current energy sector is primarily driven by the mining of domestic coal and the importation of oil. Only a small portion of the country's energy is generated through natural gas, nuclear and renewable energy sources.

In the last few years, shale gas extraction by means of 'hydraulic fracturing/fracking' has been identified as a potential new addition to the energy sources mix, and has been incorporated in the South African Integrated Resource Plan (IRP, 2016). This has sparked intense debates among the government, academia and citizens of South Africa around concerns regarding hydraulic fracturing, similar to debates on fracking worldwide.



Andrzej Kijko
and Ansie Smit

There are two main opposing views. A strong argument can be made in support of shale gas extraction, not only to serve as an energy source but also as a platform for job creation and desperately needed economic growth. On the other hand, valid questions are raised regarding the sustainability of the jobs created, the adequacy of the scientific and regulatory oversight of the extraction process, as well as the socioeconomic impact (the impact on the country's scarce water resources, biodiversity and public health) of the process.

A new book, *Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives* (JUTA, 2016) explores a broad-ranging set of questions related to proposed hydraulic fracturing or 'fracking' in the Karoo. The book is multidisciplinary, with contributors including natural scientists, social scientists and academics from the humanities, all concerned with the ways in which scientific facts and debates about fracking have been framed and given meaning.



Vaalbank - Adriaan Oosthuizen

Professor Andrzej Kijko and Ansie Smit from the Natural Hazard Centre at UP contributed the chapter on *Hydraulic fracturing, wastewater pumping and seismicity*, with colleagues from the Universities of Cape Town and the Free State – Professor Jan Glazewski, Dr Beth Kahle and Surina Esterhuysen. Kijko and Smit's focus is on the relationship between hydraulic fracturing activities and seismicity. As seen globally, this relationship is not uniform across all geological settings, suggesting that the associated hazards and risks (damages) are not identical for all regions. The chapter presents Oklahoma as a case study and describes historical and present-day seismicity in South Africa. Within the Karoo, many important questions related to the sensitivity of the injection of fluids into the subsurface currently remain unanswered.

The underlying theme of *Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives* is one of caution, which this chapter addresses for seismicity-related risks of hydraulic fracturing. The book also emphasises the need for collaboration between the natural and social sciences, and the responsibilities of those charged with the implementation and governance of the fracking enterprise, if South Africa hopes to manage fracking effectively at all.

BRIEWE UIT DIE TANKWA A FORGOTTEN PEOPLE

The Tankwa-Karoo is an area described as the vast tract of dry land roughly to the north of Ceres in the Western Cape, and to the south of Calvinia in the Northern Cape. *Briewe uit die Tankwa*, published by Protea Boekhuis (2016), vividly captures the landscape and the people who have always lived there.

“Hierdie ongenaakbare mooi, bitter eensame, donnersvêr-in-die-niks-in-plek, alkante van die R355-grondpad tussen Ceres en Calvinia, dít noem hulle die Tankwa-Karoo.”

Dr Leti Kleyn writes that *Briewe uit die Tankwa* came to her when she was asked if she is the kind of writer who can wear her underwear on both sides. Both sides? Because in the area she writes about, there is no water (the district receives less than 100 mm per year), no electricity, cellphone reception only on some farms, and thousands of kilometres of gravel road that eat tyres and shoes and everything else that passes over it.

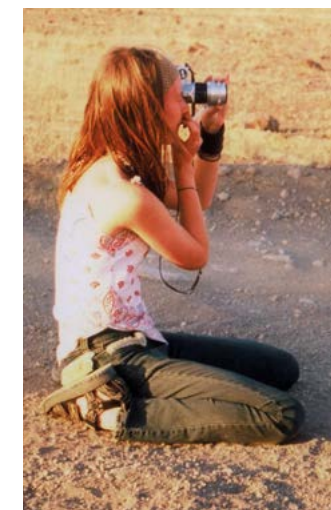
Leti Kleyn, *Die Burger*, 28 January 2017

“Between the border of the Roggeveld and the Cold Bokkeveld lies a solitary and inhospitable region which the farmers of that area call the 'Karoo'. In the southeast, it is bordered by the mountains of the Small Roggeveld. In the northwest, it imperceptibly merges with the Southern Bokkeveld and the Hantam. The region is about 100 to 120 km long and 60 to 70 km wide. The highway from Ceres to Calvinia runs diagonally through the 'Karoo'; the highway from Ceres to Sutherland runs right through the south-eastern part of the 'Karoo'. [...] From Karooport, where the Ceres road enters the Karoo, to Calvinia the world remains flat for the first part of the journey. However, the plain gradually goes over the low hills, with here and there a loose mountain to break the monotony of the relief. Further on, the landscape becomes totally mountainous, and eventually, the traveller climbs the Roggeveld edge at Bloukrans” (freely translated from Van der Merwe, 1945: 121).

The book became an attempt to document 'the invisible people' of a deadly quiet place. A forgotten community that stretches over two provinces more than 100 km each from the two nearest towns. Passing between Ceres and Calvinia on the R355 dust road – the longest gravel road between two towns – you will find nothing but a single farmstall and three or four farm houses visible from the roadside. On a lucky day, maybe a donkey cart going to visit, going to the 'shop' or just taking a little drive. Yet, in this non-commercial farming community there *are* people, with fantastic stories, memories of the past, exceptional innovations and survival techniques, and some incredible challenges. And for that you need to drive thousands of kilometres to find them – sometimes with the photographer, sometimes alone, just getting lost in the nothingness between farms trying to find people and document their stories.

The project attempted to create a book that tells three parallel narratives: The beautiful photographs of Adriaan Oosthuizen; Kleyn's historical overview of the area, combined with the information obtained from interviews; and the well-documented childhood memories of farmworker Dawid Slinger. Slinger documented his memories a few years earlier, archiving a copy at the Togryers Museum in Ceres. These writings were published in the book in a special typographical fashion to ensure that his writings, as well as a short narrative on its own, can clearly be identified as part of the broader project. It is deliberately a book within a book, rather than just making use of his information.

The project led to a variety of community engagement initiatives such as the annual Community Day and the Tankwa Community Projects initiative: www.tankwaprojects.co.za.



Leti Kleyn is a documentary writer who also manages the Open Scholarship Programme in the Department of Library Services at UP.

LIVESTOCK KEEPERS A FOCUSED SNAPSHOT OF TWO RURAL COMMUNITIES

There is growing recognition in the development literature that small-scale farming provides pathways out of poverty, towards food security and sustainable livelihoods.

Professor Vasu Reddy, Dean of the Faculty of Humanities at UP, has published *The Socioeconomics of Livestock Keeping in two South African Communities* (HSRC Press, 2016), co-authored with **Safiyya Goga**, **Furzana Timol** and **Stanley Molefi**. He and his postgraduate students travelled to rural communities to observe and study small-scale farmers and their households, their relationship to livestock, and rural community experiences in the Marble Hall (Limpopo) and Siyabuswa/Rhenosterkop (Mpumalanga) areas.

Professor Reddy writes that entry into the world of cattle and other domesticated animals was the result of an invitation by scientists at the Agriculture Research Council (ARC) working on vaccines for livestock to combat viral diseases. At the outset, he knew little about vaccine development and animal health, issues far removed from other pressing questions about the material, embodied, socio-behavioural and gendered dimensions of sexualities that usually preoccupy him.

The book, through its focus on livestock practices, presents the human and social dimensions of rural

farming systems and the relationship to household food security, socioeconomic development and improved livestock health in rural farmer households.

The team investigated behaviour patterns, usage, uptake, knowledge and attitudes among farmers in relation to vaccine usage and disease management. Vaccinations as an intervention have yielded the greatest efficacy in preventing, controlling and reducing the incidence of animal diseases worldwide. Healthy animals in relation to healthy communities play a central role in ensuring and enhancing food security. With a multidimensional team involving scientists in microbiology, agricultural economics and social sciences, the study was geared toward providing evidence to promote greater food and economic security in livestock-keeping households, through improved animal health.

Smallholder farmers who are already in precarious socioeconomic circumstances are often worst affected by livestock disease outbreaks. Livestock keeping enables households to avoid stark poverty, as they sell livestock out of necessity rather than as a purely commercial enterprise. Socio-culturally, keeping livestock, especially cattle, serves as a store of value and savings to be sold in times of need and crisis; described by one participant as a 'traditional bank'.



The ARC team tags Nguni cattle.

Safiyya Goga



Safiyya Goga

UP RECEIVES GRANTS FROM ANDREW W MELLON FOUNDATION

INEQUALITIES – A transdisciplinary project

Inequality is not simply a media buzzword but is currently an essential social and human reality – a contemporary problem in the global world. *Justice and Humanity: Challenging world (in) equalities*, led by **Professor Vasu Reddy**, Dean of Humanities at UP, is a five-year programme that makes a compelling case for the recognition of a human saliency to this topic. This transdisciplinary project will deliberately disturb established convictions so as to reinforce new, fresh and potentially powerful conceptual and empirical work on inequalities. Focused on research-driven outputs, postgraduate education and a public humanities component, the programme will be linked to the work of graduating students.

CURRICULUM TRANSFORMATION – A supra-institutional project led by UP

The Andrew Mellon Foundation approved, in 2016, a grant to the University of Pretoria to support a five-year supra-institutional collaborative programme led by the Dean as Principal Investigator, in collaboration with colleagues at six research-intensive universities: Rhodes and Stellenbosch Universities, and the Universities of Cape Town, the Free State, the Western Cape and the Witwatersrand.

Unsettling Paradigms: The Decolonial Turn in the Humanities Curriculum at Universities in South Africa is designed to strengthen knowledge and to empower our students. The aim is to generate and disseminate interdisciplinary and engaged research and knowledge focused on curriculum transformation within South African universities. The project is thus an intervention in the current epistemic, theoretical and methodological struggles being articulated around the meaning of a transformed university.

TANGIBLE HERITAGE CONSERVATION – Building research capacity

UP was awarded a planning grant for 2016 to develop a Master's degree programme in Tangible Heritage Conservation (THC). THC is the inclusive term for cultural objects of significance, including resources such as archaeological artefacts, cultural handicrafts, religious objects, water-colour paintings, beadwork, baskets and sculptures. THC resources can be divided into moveable objects (usually found in museums and art galleries) and immovable objects (structures such as monuments or architecturally designed buildings, archaeological sites, and vernacular architecture).

The envisioned academic programme will build the research capacity of a new generation of conservators and aid in diversifying the current demographics of the conservation profession.

Vasu Reddy



FREUD's ORIGINAL IDEAS ON SEXUALITY

Sigmund Freud published *Three Essays on the Theory of Sexuality* first in 1905, and then four further editions between 1905 and 1924; the revisions, which are included in the translation of the Standard Edition, obscure some of his original ideas.

In 2016, Professor Ulrike Kistner in the Department of Philosophy at UP completed the first English translation of the 1905 edition of *Three Essays* (published by Verso, January 2017). Kistner describes her philosophical inquiry as 'archaeological explorations, re-finding lost thought and bringing it to bear on contemporary questions and debates'. This seems indeed to have been the case with the task of translating this seminal work of one of the great theorists of the 20th century.

The publishers note that the first edition of *Three Essays* shows 'a radically different psychoanalysis, and in a form new to all but a few ardent students of his work'.¹ The English translation now opens this text to a wide readership, and to closer scrutiny.

The 1905 version does not espouse the Oedipal complex that came to dominate Freud's ideas and the subsequent editions of these Essays. The role of sexuality for psychic life outlined by Freud in 1905 has an emancipatory potential for the contemporary world that could revitalise Freudian thought, at a time when societies have begun the serious work of reconceptualising sexual identities. The conception of

self is no longer rooted in the assumption of a sexual identity; instead the imposition of sexual categories becomes a source of neurosis and itself a problem to overcome.

The foreword, written by Ulrike Kistner with Philippe Van Haute and Herman Westerink,² outlines the context and theoretical implications of a non-Oedipal psychoanalysis. Three points are highlighted: First, the 1924 edition became decontextualised from Freud's 1905 projects and thoughts. The same year (1905) also saw the publication of *Fragment of an Analysis of Hysteria* ('Dora'), and *Jokes and their Relation to the Unconscious*. These books illuminate each other and Freud's thinking in that period; the psychoanalytic tradition consistently gives an Oedipal interpretation of the Dora case, yet there is not one reference to the Oedipus complex in the 1905 edition, except a footnote mentioning the 'Oedipus fable'. In the 1905 edition, the crucial problematic that lies at the basis of hysteria is not the Oedipus complex, but bisexuality. Reading Dora against the background of the 1905 edition reveals a picture different from the one emerging from reading the case against the background of the 1924 edition.

A second point: the 1905 edition contains a theory of sexuality that in no way anticipates the later Oedipal theories, and allows for a critique of a binary conception of sexuality and, more generally, of sexual identity politics. It resonates well with the work of philosophers who, writing on related subjects at a later date, attempt to overcome heteronormative logics (e.g. the writings of Foucault and Deleuze, and of queer theory).

And a final point: even as the first edition articulates a new revolutionary theory of sexuality, it also remains stuck, to an extent, in age-old prejudices about sex and sexuality. Yet, it is precisely because the 1905 text illuminates, rather than simply neglects, the uncertainties and ambiguities, that it shows possibilities for new ways of thinking about sexuality that transcend the 'heterosexual matrix' that in so many ways conditions our lives.



Elite Photo Agency

¹ <https://www.versobooks.com/books/2312-three-essays-on-the-theory-of-sexuality>

² Text adapted from the Foreword; see: <http://www.versobooks.com/blogs/3065-freud-s-missing-object-the-1905-edition-of-three-essays-on-the-theory-of-sexuality>

G K CHESTERTON AND THE DRAMA OF MEANING

G K Chesterton (1874–1936), a prolific and provocative journalist-philosopher, felt that the world was almost always in permanent danger of being misjudged or even overlooked, and so the pursuit of understanding, insight and awareness became his perpetual preoccupation ... His belief was that it really is possible, albeit in a limited way, to see things as they are.¹

Dr Duncan Reyburn in the Department of Visual Arts is a leading authority in South Africa and internationally on the work of G K Chesterton. Reyburn's book, *Seeing things as they are: G K Chesterton and the Drama of Meaning* (Cascade, USA) pinpoints and addresses what has been a major gap in Chesterton scholarship to date. Although the unique interpretive stance of Chesterton is certainly the central impetus behind all Chesterton scholarship, this is the first book to focus specifically and comprehensively on this issue. In the search for meaning, the book aims to elucidate how Chesterton's work might better help us to understand and to participate in the hermeneutic experience – how we might better understand not only words but the world itself.

The book situates Chesterton within the history of philosophy and theology in a way that has not previously been done. Chesterton, as a master of paradox and as a profoundly analogical (rather than dialectical) thinker, is given his due for his many nuanced provocations, and for the way that he invites the reader to enter into the event of understanding. The book argues that Chesterton's unique hermeneutic is rooted in a Platonist-Thomist conception of being. One of the world's leading Chesterton scholars, Joseph Pearce, said of Reyburn's book that it is 'utterly unique' in the history of Chesterton scholarship.

It is not only a unique contribution, but is also the most comprehensive assessment of the relationship between theology and philosophy in Chesterton's work to date. This fact is noted by another leading

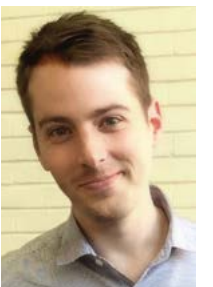


Wikimedia Commons

Chesterton scholar, Prof Alison Milbank of Nottingham University UK, when she writes the following about the book: "For far too long Chesterton has been undervalued as a philosopher, and the radicalism of his thought unacknowledged. Duncan Reyburn's superb exploration of the dramatic nature of his hermeneutics is thus a timely and original contribution to Chesterton studies, revealing on what resilient theological basis the sparkling epigrams depend."

In addition to this book, Reyburn is co-authoring one and co-editing another book (also under contract with Cascade, USA) with American scholar Dr Roberto Sirvent (Hope International University, California). He has also begun work on a second book on Chesterton.

Before shifting focus to academia, Reyburn worked as an animator, comics artist, designer, design consultant, illustrator and television commercial director. In his research, his particular interest is in the intersection between hermeneutical philosophy, political theology, mimetic theory and visual culture.



¹ <http://wipfandstock.com/seeing-things-as-they-are.html>

ANCIENT DNA PATHOGENIC DRIVERS OF HUMAN MORTALITY

Given the antiquity of human occupation in southern Africa, and its vast ecological and geographic diversity, the region is a rich repository for the discovery of pathogenic drivers of human mortality.

There is no better place in the world than right here in South Africa to explore the origins of our species. South African caves and rock-shelters have long been favoured sites of human habitation and, from 165 000 years ago, these bear testament to the origins of technological and behavioural traits reminiscent of modern humans. Archaeologists have generally focused on macro-material-cultural remains, such as stone tools, skeletal remains and ancient art, in formulating explanations concerning the past. But what about that which we cannot

perceive with the naked eye? The microbes, molecules and ancient DNA?

While much is known about the evolution of human technological and symbolic capacity, the impact that diseases have had on the biological and social evolution of our species is a largely overlooked aspect of our developmental history. It is widely stated that diseases have impacted human populations throughout history. But the biological origins of many prehistoric, historical and even modern-day diseases, remain enigmatic. Moreover, precisely which pathogens were brought from Africa to the rest of the world, after our ancestors left the continent some 65 000 years ago, is also ambiguous. The analyses of ancient skeletal remains have provided insights into the incidence of certain diseases in the

past, but the lack of well-preserved human remains renders skeletal pathology rather limiting in terms of determining the impact of pathogens on our ancestors. Accordingly, and with the aim to explore the use of alternative sources of insight into the past, **Dr Riaan Rifkin**, a Senior Postdoctoral Fellow at the **Centre for Microbial Ecology and Genomics (CMEG)**, recently initiated a pioneering research project aimed at identifying human pathogens in ancient (archaeological) sediments.

Dr Rifkin addresses two largely unanswered questions concerning the evolutionary history of our species in southern Africa: First, what is the so-called 'Pleistocene disease baseline'? And, second, in which ways did diseases have an impact on human evolution? Innovative molecular analytical techniques



Obtaining sediment samples from Wonderwerk caves.

have been successfully applied to the emerging field of ancient pathogen DNA (apDNA) and have contributed significantly to current understandings of prehistoric disease origins. And although the recovery of ancient sedimentary DNA (sedaDNA) has been reported in European and North American contexts, no ancient DNA has yet been recovered from African sediments.

How does one extract molecular information from ancient sediments? First, sediment samples are obtained from South African caves, such as Wonderwerk and Bushman Rock, where evidence of human occupation spans the Holocene and Pleistocene epochs. Samples are taken according to strict contamination-prevention protocols, as the inclusion of any modern DNA will severely limit the ability to detect the highly fragmented ancient DNA molecules. Following sample acquisition, the sealed and frozen tubes are sent to a state-of-the-art laboratory for DNA extraction and analyses. While ancient human pathogens have indeed been recovered from these sediments, stringent bioinformatic analyses are currently applied to confirm, unequivocally, the incidence of these microbes and sediments.

Given the multidisciplinary nature of bio-archaeological research, Dr Rifkin works in collaboration with **Professor Don Cowan** and **Dr Jean-Baptiste Ramond** (CMEG), and with **Professor Anders Hansen** at the Centre for GeoGenetics in Copenhagen. This contribution, and the latent significance of ancient biomolecular research, cannot be underestimated. History has taught us that disease is potentially the most effective eradicator of our species – and that past epidemics are much more than just ancient history. They are also significant drivers of human genetic diversity and natural selection.



Wonderwerk caves – Riaan Rifkin



Mother and baby in the Kangaroo Mother Care (KMC) facility at Kalafong Hospital's Neonatal Unit.
Eyescape

HEALTH

This theme combines research on human and animal health, opening with a grouping of texts on the eradication of malaria called 'a massive unfinished agenda', to re-engineering primary health care, and reducing morbidity of babies and children. A second set of research profiles covers the spectrum from basic through to clinical research and the development of new therapeutics or diagnostic tools, including cancer genetics. The focus on animal health includes the identification of biomarkers in disease to assist prognosis and disease outcomes, and the search for appropriate models to investigate *Falciparum* malaria, to the sensory organs of ratites and, working closely with the poultry industry, advances with avian respiratory pathogen research. Finally, wildlife endocrinology provides insights into the influence of environmental factors on reproduction, and supports the development of assisted reproductive technologies.

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A MALARIA-FREE AFRICA BECOMES A REALITY

Malaria remains a killer on the African continent, resulting in more than 400 000 deaths per year, even though global efforts have for some time focused on eliminating this infectious disease. Researchers of the **University of Pretoria Institute for Sustainable Malaria Control (UP ISMC)**, a South African Medical Research Council (SAMRC) Collaborating Centre for Malaria Research, have recently made breakthroughs towards malaria elimination.

It is clear that no single approach to sustained malaria control will lead to its elimination. South Africa, as part of four frontline countries in southern Africa, is leading an effort aimed at eliminating the disease by 2018/2020. Innovations, including antimalarial transmission-blocking drugs that can be combined with safe mosquito control and human protection, are key steps toward the eventual elimination of the disease.

Professor Lyn-Marie Birkholtz, who holds the DST-NRF SARCHI Chair in Sustainable Malaria Control, heads the Parasite Control Cluster in the Institute and is a Professor in Biochemistry. Her research and that of her group have shown that new antimalarial candidates have the potential to eliminate malaria. The trendsetting nature of the work has led to an invited opinion statement in the leading journal in the field of parasitology, *Trends in Parasitology*, in 2016.



Professor Birkholtz's research contributes to knowledge about the interplay between malaria control and eliminating infection by focusing on both the pathogenic and transmission forms of malaria parasites, specifically the most deadly one – *Plasmodium falciparum*. Birkholtz explains that malaria elimination can only be achieved if symptomatic patients are treated and we get rid of the transmissible forms of the parasite at the same time – this will require a 'magic bullet' drug. The discoveries of new molecules that may contribute to eliminating malaria also support a growing drug discovery industry in South Africa, which is an appealing development for the country.

Related, the work of researchers affiliated to the **South African Malaria Transmission-Blocking Consortium**,



established by Professor Birkholtz in 2013, is unique in Africa. The Consortium includes scientists from the Council for Scientific and Industrial Research (CSIR, Dr D Mancama), and from the University of the Witwatersrand Research Institute for Malaria (WITS, Professors T Coetzer and L Koekemoer). Collectively, the work undertaken by the Consortium is examining whether new antimalarial candidates that may cure an infection could also be used to block transmission of the malaria parasite from humans to mosquitoes. Malaria elimination becomes a reality only once this transmission cycle is broken.

The Consortium works closely with other experts in antimalarial drug discovery in the country, including Professor Kelly Chibale, DST-NRF SARCHI Chair in Drug Discovery at the University of Cape Town (UCT). Potential drug candidates from UCT are evaluated by UP and their partners for the ability to kill the transmissible forms of the malaria parasites in humans. As a result of this work, for the first time we are able to talk about targeting the parasite in malaria elimination, which will have far-reaching consequences in the fight against the disease.

Tiaan de Jager is Director of UP ISMC, and Dean of the Faculty of Health Sciences.



UP ISMC – A MULTI-DISCIPLINARY PLATFORM

The World Health Organisation (WHO, 2016) regards malaria as 'a massive unfinished agenda'. Despite recent progress, malaria continues to have a devastating impact, particularly on the African continent that accounts for an estimated 90% of malaria cases and 92% of malaria deaths.

The **University of Pretoria Institute for Sustainable Malaria Control (UP ISMC)** was established to promote collaborative research on safer and sustainable malaria control and management. It is a multi- and trans-disciplinary, interdepartmental and interfaculty platform that links and consolidates existing research expertise on malaria control within the University, and sustains strong links with national, regional and international partners.

Professor Tiaan de Jager, Director of the UP ISMC, notes that there is an urgent need for research and surveillance, including safer alternatives to insecticides, especially those to which the development of resistance is known. Support is needed for the continued development of new technologies and strategies as methods of sustainable alternative malaria control. At the same time, novel ways to ensure community disease awareness and support for public health campaigns are necessary to enable communities to contribute to an integrated management approach to eliminating the disease.

The different research clusters of the UP ISMC focus on human health, parasite and vector control, with research varying from molecular approaches to transmission blocking and drug testing, to innovative, novel approaches to vector control, mathematical modelling, remote sensing, health promotion, and malaria education.

The Institute hosts the DST-NRF SARCHI Chair on Sustainable Malaria Control, and is a South African Medical Research Council Collaborating Centre for Malaria Research. Recently, the Institute also partnered with Goodbye Malaria to establish a Malaria Research Centre of Excellence at Namaacha in southern Mozambique, near the border between South Africa, Swaziland and Mozambique.

FINDING THE PATH OF LEAST RESISTANCE

Drug resistance presents one of the biggest challenges in malaria control, and finding the path of least resistance is proving to be a challenging task.

Dr Bianca Verlinden's specific focus is on slowing down drug resistance in the highly adaptive malaria parasite, *Plasmodium falciparum*. She is a postdoctoral fellow in the **Department of Biochemistry**, and works under the mentorship of **Professor Lyn-Marie Birkholtz** as part of the UP ISMC.

Verlinden and Birkholtz write that the malaria parasite is 'an amazing shape shifter' that over centuries has adapted to the habits of its victim (*Conversation*, November 2015). Antimalarial drugs have a limited lifespan because by changing its DNA, the malaria parasite develops resistance with repeated exposure to antimalarial drugs. To tackle this problem, researchers are investigating potential antimalarial drugs with multiple targets to overwhelm the parasite and reduce the development of resistance.

In Verlinden's research, the first step has been to search for evidence in fields where resisting resistance may be possible: for example, in the fields of cancer and infectious disease, there are several innovative strategies used to delay resistance, especially in the multi-targeting approach that can take on several forms, such as combination therapies, hybrid drugs or integrated pharmacophores (multi-targeting drugs). Integrated pharmacophores seem most promising in the development of new antimalarial drugs that have an enhanced 'druglike'

EXCELLENCE REWARDED

Dr Verlinden's research contribution resulted in her being chosen as one of the Top 100 Future Leaders of South Africa, from a pool of over 3 500 applicants, as part of the 2016 GradStar Awards Programme. In 2016 she was also chosen by the National Research Foundation as one of two excellent, young researchers to represent the country at the 8th HOPE meeting with Nobel Laureates for the promotion of science, held in Japan. At this meeting she was chosen as the sole recipient of the prestigious HOPE Award for research excellence from among 109 young international scientists.



profile, but are multi-targeting. The analogy used is that of a pharmaceutical skeleton key. Since an integrated 'skeleton key' is aimed at several different targets, it would exponentially be more efficient in resisting resistance, and more difficult for the cell or microbe to adapt simultaneously to all targets, in comparison to a single drug target.

The antimicrobial skeleton keys that Verlinden studies are organic compounds known as polyamine analogues, which have been shown to inhibit the growth and regulation of target cells. She has previously screened three polyamine analogue libraries against sensitive and resistant strains of the pathogenic and transmissible stages of the malaria parasite. The majority of the polyamine analogues were highly active against both forms of the parasite. They also demonstrated excellent selectivity towards the parasite when compared to mammalian cells. The lead candidate demonstrated a multi-target mode of action that did not lead to parasite-resistant mutants, which provides proof of principle that the chemical structure of the lead polyamine analogue has the potential to limit resistance development in the malaria parasite.

EARTH OBSERVATION FOR MALARIA CONTROL

Malaria is highly sensitive to climatic variability, and since mosquitoes thrive in warm, moist environments, it is anticipated that global warming will have an impact on the spread of malaria across southern Africa.

Bilateral discussions between the **University of Pretoria Institute for Sustainable Malaria Control** (UP ISMC), and the **Centre National d'Études Spatiales** (CNES, the French National Centre for Space Studies), have now culminated in an established programme, the **Remote Sensing for Malaria Control in Africa** (ReSMaCA) programme. The stakeholders of this initiative are the UP ISMC, CNES, the South African National Space Agency (SANS), South African Weather Service (SAWS), the Institute of Research for Development (IRD, France) and the Council for Scientific and Industrial Research (CSIR). Researchers from several South African, African, French, and other international tertiary and research institutions, will also contribute to this collaboration.

The programme is based on the use of remote sensing and satellite technologies to assist in malaria control. By monitoring epidemics and merging health data with environmental and climatic

data, researchers can identify conditions that are likely to promote and increase the prevalence of malaria in order to gain a better understanding of the mechanisms involved in the spread of the disease. Increased cross-border movement of people between South Africa and its neighbouring countries, Mozambique and Zimbabwe, in particular, is a further area of concern, and is the focus of monitoring as the prevalence of malaria is high in these areas. **Professor Riana Bornman** (below left), a senior research fellow in the **School of Health Systems and Public Health**, and a member of the UP ISMC, is closely involved in the programme. Her work on cross-border movement and the impact of malaria on South Africa is now incorporated in the ReSMaCA programme.

A good climate-modelling system for malaria is an important tool for providing early warning on possible outbreaks and for studying the potential impact of future climate change on malaria. This will necessarily entail mathematical modelling and other data analytics technologies to investigate the impact of climate variability as well as other factors on malaria, to expand on the current predictive malaria-risk maps, and to develop early warning- and better surveillance systems.



UP ISMC researchers with colleagues from CIRAD, France.

MALARIA CONTROL INNOVATION

REPELLENTS AND SLOW-RELEASE FILAMENTS

A reason for the continued prevalence of malaria in endemic areas is the lack of adequate vector control measures. Researchers in the **Institute of Applied Materials (IAM)** in the University's Faculty of Engineering, Built Environment and Information Technology are working on innovative vector mosquito-repellent inventions. The research falls under the ambit of the UP ISMC vector control cluster.



The World Health Organisation (WHO) recommends long-life insecticide-treated nets and indoor residual spraying for malaria vector control, but both interventions target mosquitoes that feed indoors. A significant proportion of malaria infections in Africa may be due to exposure to vector mosquitoes during the early hours of the evening when people are still active outdoors.



N,N-diethyl-meta-toluamide (DEET) is considered to be 'the' mosquito repellent for outdoor personal protection because of its superior residual efficacy. However, numerous product shortcomings have indicated a need for replacements. DEET's residual effectiveness is only a few hours. Its relatively high cost and the need for repeated application to the skin at high concentrations (10 to 70%) preclude its use in tropical countries. There have also been emergent resistance and negative consumer perceptions with respect to aspects such as odour, high adsorption rate, oily feel on the skin and skin irritation.



IAM researchers **Homa Izadi**, **Professor Walter Focke** and **Professor Leo Braack** have noted that commercialising new active compounds and establishing their safety for human use are time-consuming and expensive. The discovery of synergistic mixtures of approved repellents could provide a faster route to the public use of replacement repellents. Through their research, Izadi, Focke and Braack have discovered a special blend of two repellents with pseudo-azeotrope behaviour that improve repellent efficacy and persistence. This approach opens the way for the development of better mosquito repellent formulations to fight mosquito-borne diseases.



Left from top: Homa Izadi, Walter Focke, Leo Braack and Mthokozisi Sibanda.
Right: Collecting vector mosquitoes in Uganda.

Another project undertaken by researchers **Mthokozisi Sibanda** and **Professor Walter Focke**, in collaboration with Dr Andreas Leuteritz and Dr Harald Brünig of the Leibniz Institute for Polymer Research in Dresden, Germany, has successfully produced personal protection clothing items. A need was identified for a slow-release, affordable, mosquito-repelling bi-component polymer filament

for the production of personal protection items to reduce outdoor malaria transmission in resource-limited countries.

A bi-component polymer yarn was developed with a core containing a volatile repellent active, and a sheath layer that reduces the rate at which the active ingredient is released into the atmosphere. The yarn can be knitted into personal protection clothing items such as repellent socks or ankle covers that can be used to reduce mosquito bites on the ankles and feet. Initial mosquito repellent properties are excellent. The long-term performance of these mosquito-repelling socks was demonstrated via

ageing tests, which showed that the repellence effect lasts for more than eight months, and is retained after twenty washes.

The concept of trapping DEET and slowly releasing it into the environment using bi-component filaments should allow for the production of textile-based personal protection items to reduce outdoor malaria transmission. The concept can, in future, be considered for weaving or knitting into fabrics or for use in netting. This technology is currently in the commercialisation process and shows the effective integration of research into solutions for real-world problems.



RE-ENGINEERING PRIMARY HEALTH CARE

The **Department of Family Medicine** at UP has developed a 'high tech, high touch' service-learning-research system that is re-engineering primary care through an ICT-enabled Community Oriented Primary Care (COPC) programme.

COPC is an integrative and holistic approach to primary health that is scientifically informed and practice driven. It is guided by principles that draw on the best available understanding and practice of inclusive primary health care, which:

- Is built from and rendered to individuals and families living in defined geographical areas
- Delivers health care along the service continuum promotion-prevention-treatment-rehabilitation-palliation
- Integrates patients through the different levels of the system and requires and promotes collaborative multidisciplinary teamwork
- Integrates public, private and third sector organisations to make wellbeing, health conditions and health services a shared responsibility of service users and service providers.

COPC is enabled by Aitahealth™, a purposively designed, modularised device and web application developed in partnership with MezzanineWare

(Vodacom) and Synaxon. The device and web application support the routine collection and real-time use of health and service information, with the information gathered providing a systematic base for research.

The ICT-enabled COPC was first piloted by the Department of Family Medicine at seven sites in Tshwane district between 2011 and 2013, and since 2014, has been further developed and implemented with the City of Tshwane in Mamelodi, Soshanguve and the Inner City. In 2016, the Gauteng Department of Health supported by the UP Department of Family Medicine began the phased roll-out across all five provincial health districts.

Professor Jannie Hugo, **Professor Tessa Marcus** and **Dr Hans-Freidemann Kinkel** are directly involved in research into COPC through the COPC Research Unit. The areas of primary care that are being investigated include monitoring to inform, redirect, strengthen and improve services, and evaluating priority health care interventions with respect to their impact on local health, and in relation to provincial and national development goals and the global UN Sustainable Development Goals (SDGs). The COPC Research Unit is also involved in basic science investigations and big data modelling.



COPC capturing primary health care information.

Wouter Jacobs

LINKING HARMFUL SUBSTANCE USE TO COMMUNITY-ORIENTED PRIMARY CARE

In the implementation of the Community Oriented Primary Care (COPC) programme in the City of Tshwane, the extent and the complexity of harmful substance use and the impact on the health and social functioning of individuals, families and communities, have become increasingly evident.

Professor Jannie Hugo and researchers in the **Department of Family Health** have emphasised that the main focus needs to be on treatment and rehabilitation, and not on policing and a criminal justice response to the problem. Although widely recognised that drug and alcohol abuse contribute to the burden of disease in society – and to family and community conflict, crime and economic instability – the dominant approaches have been largely ineffectual. **Shaun Shelly**, also in the Department of Family Health, writes that although many South Africans are calling for harsher drug policies, there is increasing recognition internationally that criminal justice approaches are not effective. He references Kofi Annan, former United Nations secretary general and commissioner on the Global Commission on Drug Policy, who commented that: "Drugs have destroyed many lives, but wrongheaded governmental policies have destroyed many more. I think it's obvious that, after 40 years of the war on drugs, it has not worked."

Given the health risks of drug use in a TB and HIV epidemic and the social need for an effective response, the Department of Family Medicine has partnered with the City of Tshwane to develop a community-oriented substance use programme (COSUP). It is a primary care programme that uses a harm-reduction approach to prevent and manage substance abuse, to reduce and/or contain injecting drug-driven TB and HIV infection, and to improve the quality of life of individuals and families affected by substance abuse.

COSUP is a three-year collaboration that involves government, university departments and third sector organisations, among others, the City of Tshwane, the Gauteng Department of Health, the



UP Department of Social Work and Criminology, the SEDIBA Hope Clinic, and OUT Wellbeing. The implementation of COSUP in the City of Tshwane is also being researched as a community-based, multidisciplinary, multisectoral harm-reduction approach to substance use. It draws on data generated from screening processes, network development and service delivery information that are generated in the course of service development and implementation. In addition, specific qualitative and quantitative enquiries are being developed and included as issues requiring further research emerge. Constant collection of data and programme observation for monitoring and evaluation are essential to determine outcomes and inform strategies for improvement which, if effective, could rapidly be scaled up.

Researchers in the Department of Family Health linked to COSUP: **Professor Jannie Hugo**, **Professor Tessa Marcus**, **Dr Lindi Shange**, **Shaun Shelly**, **Dr Andrew Scheibe** and **Dr Lorinda Kroukamp**.



STILLBIRTHS PROGRESS AND UNFINISHED BUSINESS

South Africa has approximately 32 000 babies stillborn every year, many of whom die before the onset of labour. In the vast majority of cases, there is no obvious cause.

The **Research Centre for Maternal, Fetal, Newborn and Child Health**, and the **South African Medical Research Unit (SAMRU) for Maternal and Infant Health Care Strategies** at UP are currently involved in a series of research projects aimed at preventing stillbirths and reducing morbidity of babies and children. Three examples are given of research projects that are concerned with attaining the Sustainable Development Goals (SDGs) and global strategy of survive, thrive and transform in maternal, newborn and child care.

The SAMRU and the Council for Scientific and Industrial Research (CSIR) developed the Umbiflow, a simple handheld apparatus that detects the blood flow in the baby's umbilical cord. **Dr Spencer Nkosi**, working in Mamelodi, has shown that with the Umbiflow he can detect babies at risk and has managed to reduce the mortality rate of babies by half in women who have undergone this test. This exciting finding is being tested in nine other sites in South Africa in a study run by **Dr Tsakane Hlongwane**. Further, the World Health Organisation (WHO) and the Bill and Melinda Gates Foundation (BMGF) are interested in repeating the Mamelodi study in India and Kenya under the auspices of the UP Research Centre for Maternal, Fetal, Newborn and

Child Health. If the findings of the Mamelodi study are repeated, a significant breakthrough will have been achieved in preventing stillbirths.

A second example is a new device that can be used to assist mothers at the end of labour who need help in delivering the baby. Traditionally, this has been performed by using a set of forceps or a vacuum apparatus. The UP Research Centre, together with the WHO, is coordinating a study testing a new device, called the Odon device, in five sites in South Africa under **Dr Valerie Vannevel**.

The device, if proved successful, is much easier and safer to use than the traditional methods and will probably be suitable for use by midwives working in small health units. This method could significantly reduce the number of babies who develop brain damage due to a prolonged second stage of labour. The study is funded by BMGF.

A third example relates to the stunting of children, which is a major problem in South Africa and is also associated with neurodevelopmental delay. This situation is particularly prevalent in children born to women who are HIV-infected, but the babies themselves are not infected. The reasons are unclear. **Professor Ute Fuecht** is running a study that includes **Professors Theresa Rossouw** and **Mphele Mulaudzi** and **Dr Felicia Molokoane** where the growth of the baby in the uterus and the first year after birth will be followed to ascertain whether the cause of stunting is due to the in-utero environment (the response of the mother to the HIV infection, or due to the antiretroviral drugs used), or due to postnatal environmental factors such as diet and feeding practices. Understanding these factors is essential in order to start managing the problem.

Professor Robert Pattinson is Director of the SA Medical Research Council/ UP Maternal and Infant Health Care Strategies Research Unit and clinical head of the Department of Obstetrics and Gynaecology in the Faculty of Health Sciences. Here in discussion with Registrars at Kalafoong Hospital, Drs Rabothata (left) and Minisi.

BRAIN-BODY DIALOGUES AND THE PRODUCTION OF HORMONES

The Centre for Neuroendocrinology: Brain-Body Dialogues is a new Research Centre in the Faculty of Health Sciences, established in 2015.

Directed by **Professor Robert Millar**, and supported by principal investigators, **Dr Claire Newton** (Deputy Director), **Dr Ross Anderson** and recently **Dr Iman van den Bout**, the Centre has in a short span of time already recruited 15 members of staff and students.

Research in the Centre addresses the way in which the external and internal (body) environments are detected by the brain and integrated in the hypothalamic area to produce hormones that regulate all aspects of body health including stress, metabolism, appetite, growth and reproduction. Disturbance of this homeostasis results in debilitating diseases such as obesity and diabetes, a failure to grow, infertility, and cancers of the prostate, breast and female reproductive tract.

Research is characterised by the continuum of basic through to clinical research with a major emphasis on the development of new therapeutics or diagnostic tools. Three research highlights in 2016 include:

A new treatment for hot flushes in post-menopausal women

Professor Robert Millar has worked with Euroscreen, a biotech company in Belgium, to develop an antagonist of Neurokinin B, a hypothalamic hormone. Professor Millar hypothesised that a Neurokinin B antagonist would provide treatment for polycystic ovarian syndrome (which affects 30% of women) and hot flushes (which affects 60–80% of post-menopausal women). This compound has now proven to be successful in reducing the frequency and severity of menopausal hot flushes in a Phase IIa clinical trial, and a large-scale Phase IIb trial is now being planned.

Identifying a drug that restores function to inactivating mutations of receptors

A primary focus of the Centre's research revolves around the breakthrough discovery that function can be restored to inactivating genetic mutations in human G-protein-coupled receptors (GPCRs),

which are responsible for cell communication.

Dr Claire Newton and Dr Ross Anderson have fully characterised inactivating mutations in the human luteinising hormone receptor, the conduit for stimulation of the ovaries and testes, which have been identified in patients suffering from reproductive dysfunction. They found that most of the mutations result in a failure of the receptors to traffic to the cell surface, preventing interaction with their hormone signal and therefore rendering the receptors non-functional. They have also discovered a novel small-molecule compound that is able to enter cells and stabilise such mutant receptors so that they are expressed on the cell surface, therefore restoring their function. Clinical proof-of-concept studies are now being initiated with patents harbouring mutations, which they have shown can be rescued *in vitro*.

Development of a novel prostate-cancer therapeutic

A research highlight is the development of a Gonadotropin-releasing hormone (GnRH) analogs that ameliorates the negative side-effects of current therapeutics. GnRH analogs are the mainstay of prostate cancer treatment by depleting androgen. However, the concomitant depletion of oestrogens, which are synthesised from androgens, produces adverse side-effects of hot flashes and loss of bone and libido. Researchers at the Centre proposed that GnRH analogs conjugated to oestrogens could retain both GnRH and oestrogen activities in a single molecule, thereby achieving both androgen deprivation and oestrogen replacement with resultant amelioration of side-effects. They have demonstrated that conjugates of GnRH analogues to estradiol or the phytoestrogen, genistein, are active at binding and activating the GnRH receptor, and also activate oestrogen receptors *in vitro*. They now propose to undertake more detailed *in vitro* studies and also to demonstrate that the compounds are anti-androgenic and oestrogenic in male rats.



Robert Millar

CANCER GENETICS

IDENTIFYING INDIGENOUS RISK DOMAINS

It is estimated that among South African men, at least one in every 23 will develop prostate cancer in their lifetime, and that prostate-related deaths will double in sub-Saharan Africa by 2030.

Three risk factors for prostate cancer have been validated in clinical trials: ancestry, age and family history. Yet scientists still know very little about the reasons for a disparity in the risk profile and incidence of prostate cancer in Africa, and in sub-Saharan Africa in particular, compared to other regions. In the western world, prostate cancer has the highest incidence of all male-associated cancers and the second highest mortality rate. In African countries, including South Africa, the incidence of this type of cancer among non-migrant Africans is uncertain, but a trend towards patients being diagnosed at an earlier age has been observed. Confounding the complexity of this disease is the fact that the incidence and mortality rates are dramatically masked by the impact of infectious diseases on the average life expectancy of South African men.

Professor Riana Bornman, Senior Research Professor in the **School of Health Systems and Public Health** at UP's Faculty of Health Sciences, has been involved in prostate cancer research for several years, specifically among African men. Her research and clinical work has spanned several urban and rural areas in South Africa. In her view, understanding the drivers of this disease remains one of the biggest clinical challenges.

Since 2008, Professor Bornman has collaborated with Professor Vanessa Hayes, Head of the Human Comparative and Prostate Cancer Genomics



Laboratory at the Garvan Institute, Australia. Prof Hayes also holds an extraordinary professorship at the School of Health Systems and Public Health at UP. They are working on the first comprehensive next-generation mapping of an entire prostate cancer genome and expect to find novel genomic rearrangements that were not possible with previous technology. Their hope is that the outcomes of the study will have clinical potential for prognosis, diagnosis and therapeutics, and eventually help to define African-specific risk areas and the genomic signature of prostate cancer in South African men.

What is urgently required are biomarkers of specifically aggressive prostate cancer disease tailored for South Africa and sub-Saharan Africa; and further, to extend research linkages to other countries in Africa. If both environmental and genetic factors are contributors to susceptibility and disease course, and specific risk domains are found, then the question becomes *what can and must be done?*

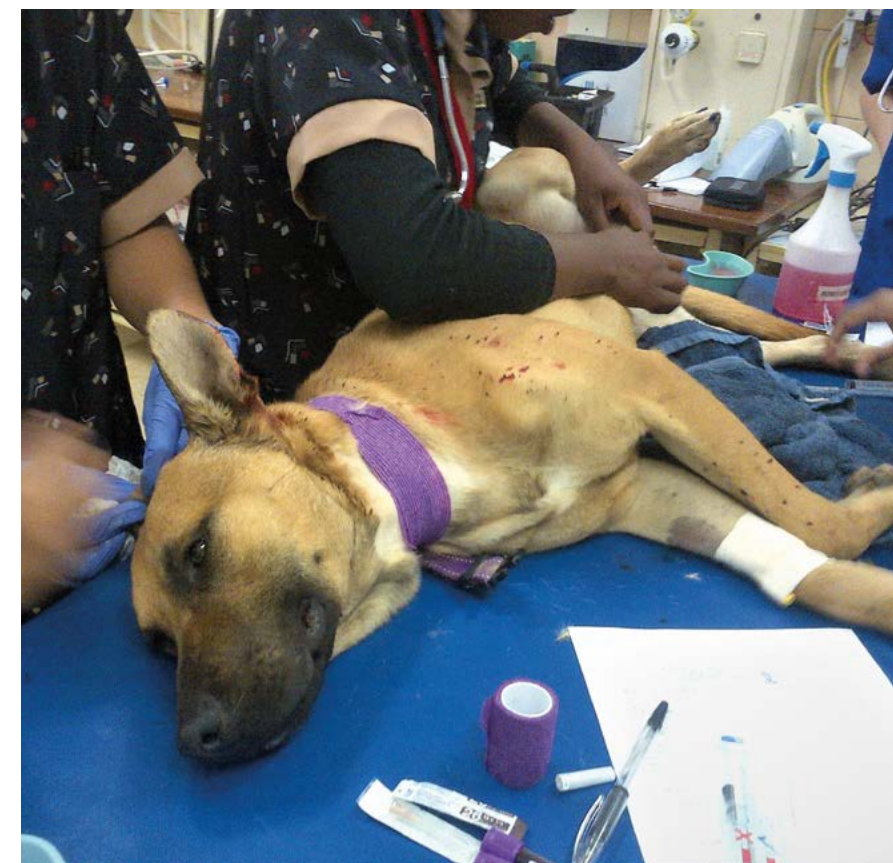
CANINE BABESIOSIS

INTERACTION BETWEEN INFLAMMATION AND HAEMOSTASIS

Blood clotting abnormalities in inflammatory disease conditions, specifically related to the risk of organ microthrombosis, are still largely underexplored yet are highly relevant in animal diseases. Using canine babesiosis (a parasite disease causing biliary and tick-bite fever or *bosluiskors*) as a model, **Professor Amelia Goddard** has gained insight into the complex interaction between haemostasis and inflammation, as well as the host response to inflammation.

Professor Goddard forms part of a group of researchers in the **Department of Companion Animal Clinical Studies** in the **Faculty of Veterinary Sciences** at UP interested in the inflammatory-haemostasis-metabolic axis in several infectious and non-infectious inflammatory conditions. The group's focus is on the progression of systemic inflammation and they hope to identify biomarkers that would assist in prognosis and in disease outcome. Professor Goddard's research results have established that dogs with clinical babesiosis, caused by *Babesia rossi*, suffer from a blood-clotting disorder triggered by an overwhelming pro-inflammatory host response, which may result in death following organ failure as a result of microthrombosis. The activation of blood platelets also appears to play a central role in the host response to inflammation. The research findings related to the presence of excessive concentrations of pro-inflammatory cytokines, specifically in dogs that died of babesiosis, were published in 2016 (Goddard *et al. PLoS ONE*, 11(3)).

The research findings have contributed towards further research in comparative medicine and translational research, and will inform future research efforts in several important ways. For example, the potential use of canine babesiosis as an appropriate model to investigate *Falciparum* malaria, regarded as the deadliest parasite in humans, is important. There is also sufficient evidence in the literature to suggest that the blood vessel wall plays



a critical role in the pathogenesis of inflammatory diseases. Thus, it would be important to investigate the presence of endothelial cell markers in dogs with babesiosis (i.e. cell markers in the thin layer of cells that forms an interface between circulating blood and the rest of the vessel wall), and their correlation with previously identified biomarkers, as well as with disease outcome.

Emergency treatment of a dog with biliary.

SENSORY ORGANS OF RATITES

Birds use their beaks in complex tasks, such as probing in the ground for worms, and typically have a collection of sensory receptors in the bill tip. These specialised organs called Herbst corpuscles are stacked in bony pits or underneath the bill skin, and have been described for example in the kiwi and in probing shorebirds.

Professor Martina Crole's research in the Department of **Anatomy and Physiology** in the **Faculty of Veterinary Science**, exposes and explains certain peculiarities and specialisations in the oropharynx and beak of farmed ratite species: the African ostrich, the Australian emu and the South American rhea. These birds all belong to an extraordinary infraclass, the Palaeognathae, with

Professor Martina Crole received the FEI prize for the best paper published in an internationally recognised Journal of Life Sciences, at the 53rd Annual Conference of the Microscopy Society of Southern Africa.

only the kiwi (New Zealand), cassowary (New Guinea), and tinamous (Mexico, Central and South America) comprising the rest of the infraclass.

Through her research Crole has demonstrated that the ostrich and emu also possess a bill tip organ, which is unusual as these birds do not perform complicated tasks with their beaks. Researchers have also determined that the part of the brain responsible for processing information from the bill tip organ is not enlarged. In collaboration with the Royal Veterinary College, University of London (UK), Crole and fellow researchers have applied elemental analysis to histological specialisations in the ostrich bill skin. This has revealed a possible function of the bill tip organ in the ostrich and emu. The bills are light yet tough, and elemental analysis demonstrates that the bill tip organ has the ability to interpret bite and pecking force. This mechanism in the non-probing ratites likely prevents them from applying a force that would break their beaks.



Joern Pollex, Getty Images

AVIAN RESPIRATORY PATHOGENS

While the poultry industry in South Africa is the single largest contributor to the agricultural sector, the impact of disease on production remains significant. Avian influenza and Newcastle disease are highly infectious and are the most important threats to poultry production, but there are many other pathogens that also cause significant problems.

Professor Celia Abolnik holds the **Research Chair in Poultry Health and Production** in the **Faculty of Veterinary Sciences** at UP. Her research is aimed at advancing knowledge on poultry diseases, specifically the avian respiratory pathogens. In addition to Avian influenza and Newcastle disease, the focus has been on infectious bronchitis and mycoplasmosis. She notes that on a practical level, the research being undertaken translates into more sensitive, cost-effective, automatable and rapid diagnostic assays, as well as better vaccines and epidemiological data. From an academic perspective, the knowledge generated on mechanisms of disease and pathogenesis, viral evolution, and the understanding of host responses and interactions between co-infecting pathogens, produces work of a high international standard.

In 2016, the research team completed two large clinical trials on the infectious bronchitis virus for an international vaccine producer, and released the first complete annotated genome for the poultry pathogen *Mycoplasma pullorum*. A molecular study of H6N2 influenza was published in *Virology*.

In South Africa, Professor Abolnik works closely with the poultry industry, national veterinary laboratories,

the Council for Scientific and Industrial Research (CSIR), and researchers at several other universities. Internationally, the Chair's network of collaborators includes institutions such as Agricultural Research for Development (CIRAD) in France, the Southeast Poultry Research Laboratory (SEPR) in the United States, and the joint OIE/FAO (World Organisation for Animal Health/ Office International des Epizooties and the Food and Agriculture Organisation) international scientific network for the control of animal influenzas.

Since the Research Chair was established in August 2012, much has been achieved in advancing knowledge on poultry diseases. In addition to the research programme established and outputs produced, a Biosafety Level 3 laboratory was commissioned and completed, and a molecular research laboratory equipped. Professor Abolnik notes that problems with the diseases are by no means solved, and that there are many other issues that the poultry industry would want to be researched, including Gumboro disease, salmonellosis and antibiotic resistance.



SEARCHING FOR THE DIRTY TRUTH

REPRODUCTION, HEALTH AND WELLBEING OF WILDLIFE

Wildlife endocrinology provides valuable information about the mechanisms regulating reproduction and the responses to stressors, thereby contributing to conservation efforts. Research provides insights into the influence of environmental factors on reproduction and supports the development of assisted reproductive technologies.

The Endocrine Research Laboratory (ERL) at UP addresses questions concerning the regulative endocrine mechanisms in mammals, reptiles and birds, with the focus on developing and validating non-invasive tools to monitor the reproductive functions and responses to stressors in wildlife, and in domestic animals. Since its establishment in 2009, the ERL has developed numerous non-invasive tests for a wide range of species, and has been pioneering techniques in Africa. The core work of the laboratory involves non-invasive endocrine monitoring of faecal samples from a wide variety of animals.



Stefanie Ganswindt

Professor André Ganswindt, recently appointed Director of the Mammal Research Institute in the Faculty of Natural and Agricultural Sciences, writes that monitoring reproductive functions and responses to stressors in wildlife can be challenging, especially when working with elusive and dangerous animals. Capturing wildlife to collect blood samples usually causes a stress response, making it difficult to determine natural cause-and-effect relationships. Furthermore, frequent blood sampling may be harmful, particularly to small animals such as Spiny mice, Elephant shrews, or African lesser bushbabies. Non-invasive methods have gained popularity over the past 30 years as a more practical approach for assessing ovarian, testicular and, more recently, adrenocortical activity in wildlife. The alternative hormone matrices now most commonly used are urine, saliva, feathers, hair, and especially faeces.

Faeces are the best hormone matrix that can be collected without disturbing the animal. Faecal hormones can provide useful information on female and male reproductive status, as well as adrenocortical function as a measure of stress. For example, Professor Ganswindt's team is able to determine pregnancy in free-ranging white rhinos by monitoring the levels of progestogens. The group is able to examine the welfare implication of dehorning by measuring glucocorticoid concentrations, an approach that contributes towards efforts to protect endangered species like the rhino.

Hormone metabolism and excretion are highly species-specific processes, and this specificity even applies to closely related species. Tests must therefore be validated for every new species studied. Professor Ganswindt explains that only certain types of hormone, or rather their metabolites, can be quantified. The ERL focuses on quantifying steroids, and to a lesser extent amine hormones, because other compounds, such as protein hormones, are completely degraded by the time defecation takes place.



André Ganswindt

While faecal hormone analysis provides valuable insights into the endocrinology of animals, it offers researchers more. A previous study that established a method for monitoring stress in crocodiles has subsequently served as a proxy for determining water health across South Africa, where faecal samples have been collected from crocodiles in pristine areas and in areas prone to pollution. A comparison of stress-related hormone levels in those crocodiles provides critical information on the status of South African water and about the health of ecosystems. Similarly, a project assessing testicular and adrenocortical activity in giraffe now provides the basis for an ongoing study on the impact of social and ecological variability on the endocrine pattern in male giraffes.

Professor Ganswindt collaborates closely with a number of international researchers and the ERL's vast and continually growing collection of sample material serves as a database that is readily available to those involved in similar projects. In 2010, Ganswindt and some international colleagues

founded the International Society of Wildlife Endocrinology (ISWE). The connection between the ERL and the international research community that has been facilitated by the ISWE, has created several new research opportunities.

The species on which Professor Ganswindt and the team at ERL have collected data include elephant, rhinoceros, African buffalo, giraffe, wildebeest, zebra, crocodile, leopard, cheetah, wild dog, aardwolf, sengi, bat-eared fox, Vervet monkeys, bushbaby, mole-rat, and even cat sharks. International collaborations with research groups from India, Great Britain, Australia and Canada further include species like tigers, Golden langurs, meerkats, sugar gliders and ground squirrels. Professor Ganswindt also serves as a research associate at the National Zoological Gardens in Pretoria, South Africa, where further collaborative projects, predominantly on birds, are being conducted. A satellite facility at the zoo studies African penguins, ground hornbills, Sungazers, and Bullfrogs.

Adapted from text by Louise de Bruin, http://www.up.ac.za/en/news/post_2141307-searching-for-the-dirty-truth



NATURAL ENVIRONMENTS

The theme covers a spectrum of environments, with research focusing on microbial populations in desert soils, the impact of climate change on desert birds, the use of mountain ants as bioindicators of temperature change, and soil erosion as a critical environmental issue. Mathematical modelling can be used to test assumptions relating to ecological processes, such as the Allee effect and critical survival thresholds. The theme also includes the latest research on the effects of environmental change on marine mammals, and the coexistence of two species of differing lifespan and body size and how they organise their reproductive biology in unison with the changes in day length and temperature.

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THE NAMIB DESERT

SURVIVING THROUGH A DRY SPELL

It hasn't rained in the central Namib Desert since 2011, and there is little visual evidence of life on the desert surface.

Despite the extreme nature of the desert soil habitat, **Professor Don Cowan** and his research team at the **Centre for Microbial Ecology and Genomics (CMEG)** have demonstrated that the microbial populations in these arid soils are alive and well. The group has been asking fundamental questions of the nature of desert soil microbial community structures, functions and adaptations. The latter has led to their recent publication, in *Nature Reviews Microbiology*, of a comprehensive review of the molecular adaptations used by bacteria to survive desiccation.

Professor Cowan and the CMEG researchers use a suite of modern molecular phylogenetic and metagenomics technologies, heavily based on the use of Next Generation nucleic acid sequencing and complex bioinformatics programmes and pipelines. He notes that CMEG researchers have been able to determine the true diversity of all important desert soil microbial taxa – bacteria, fungi, archaea and even their viruses. The use of complete metagenome sequencing has provided detailed information on the genetic potential of these community members: the genes involved in stress-responses, the pathways for nitrogen and carbon turnover, the genetic capacity of degradation of xenobiotic compounds, and much more.

CMEG researchers have used a wide range of different desert habitats, gradients and transects in their studies. Their early studies focused on the unusual water gradient across the 200 km breadth of the Namib Desert, where the western coastal zone receives frequent fog water input but almost no rain; the eastern mountain zone receives regular seasonal rainfall; and the central hyper-arid zone receives little of either! This natural gradient provides a near-unique system to investigate the nature and extent of water input on desert soil ecology.

In their latest field experiments, CMEG researchers have shifted their focus from microbial community structure to microbial community functions and responses. A year-long survey of microbial community composition showed that community structures were relatively static, but responded rapidly to the one brief shower of rain, with a rapid increase in the dominance of the cyanobacteria, the keystone taxa in desert soils. A short-timescale experiment, with soil samples recovered at eight-hourly intervals over just four days, showed that community functional responses were remarkably adaptable. These findings are important in terms of understanding how desert soil microbes may respond and adapt to the effects of future climate change.



There is much more to do, and many important questions remain to be answered. For example, the role of bacteriophage and viruses in desert soils is completely unknown. These 'organisms' are critically important in controlling host population sizes (such as 'algal blooms') in aquatic ecosystems, but Professor Cowan and his colleagues have hypothesised that their role in desert soil ecosystem dynamics may be much less – since the absence of water limits the viruses' capacity to move from one part of the community to another. Little is known about process rates: how much atmospheric nitrogen do desert microorganisms fix into the soil, and how quickly do the specialised hypolithic communities (green biofilms living on the undersides of translucent quartz rocks embedded in the desert pavement) actually grow. CMEG researchers have set up a special field experiment to measure this rate. Professor Cowan notes that they hope to have an answer by 2020.

TEAM EFFORT

Each year for the past seven years, Professor Don Cowan, along with colleagues from the University of the Western Cape (Professor Marla Trindade) and the University of Cape Town (Professor Ed Rybicki), has organised and hosted a field expedition to the Gobabeb Research and Training Centre in the central Namib Desert. Situated on the banks of the (mostly dry) Kuiseb River, the Gobabeb field station has superb access to both the northern gravel deserts and the southern sand-dune ('sand sea'). Working in close collaboration with the Centre's Director, Gillian Maggs-Kölling, and legendary ex-Director Mary Seely, Professor Cowan's approach has been to gather a team of national and international researchers with complementary interests in the many aspects of desert soil ecology. Thirty-five scientists participated in the week-long field expedition in April 2016.

In their seven years of work in the Namib Desert, Professor Cowan has hosted 41 CMEG members, and over 60 visitors from other South African, African and other continental universities. Several collaborative research programmes have developed from these visits: for example, on soil respiration processes; plant *rhizosheaths* (a specialised adaptation of desert plants, which involves a sheath of mineral particle and bacteria around the roots); the spatial aspects of Fairy Circles (see Ramond article on page 79) and desert hypolithic biology; the quartz surface microenvironment of hypolithic bacteria; and unravelling the extraordinary genetic complexity of previously unknown species of Namib Desert springtails.



AFRICAN SOIL MICROBIOLOGY PROJECT

Of all the continents, Africa faces the largest challenges concerning soil conservation and food security, in the face of increasing populations and environmental change. With the growing understanding that soil microorganisms play an important role in soil health, and therefore in the growth and productivity of economic crops, it is becoming increasingly important to understand the diversity and function of soil microorganisms.



AfSM meeting at the Centre for Microbial Ecology and Genomics at UP.

Scientists from the University of Pretoria and ten sub-Saharan African countries, along with two international scientific advisors, met in mid-2016 at the University to launch a new and exciting research project: the **African Soil Microbiology project (AfSM)**. This three-year project, funded by USAID and the Oppenheimer Foundation, and administered by the South African Department of Higher Education and Training (DHET), aims to undertake a broad-scale survey of soil microbiology across a significant proportion of the African continent, using the latest Next Generation DNA sequencing and computational technologies. Soil microbiology diversity 'fingerprints' will then be correlated with a range of variables, including soil chemistry, regional and climate parameters, land use, vegetation type and more.

Collaborators from the partner nations (South Africa, Namibia, Botswana, Zimbabwe, Mozambique, Kenya, Zambia, Ethiopia, Benin and Côte d'Ivoire) are undertaking a series of soil sampling 'campaigns', with samples recovered from 50km-spaced GPS-located sites across each country. Soil samples are returned to the University of Pretoria where CMEG researchers, together with young researchers from each of the partner nations, will process the samples, extract metagenomic DNA, and analyse the Next Generation phylogenetic sequence data.

This unique multinational project, the first such study ever to be undertaken in Africa at this scale (and, indeed, in the world), is expected to unravel the complexities of soil microbiological diversity across sub-Saharan Africa. The results of the research will contribute to our understanding of soil fertility, of soil degradation and the future impacts of climate change, and of important health issues such as soil-borne pathogens.

The launch of the project was featured in an article by Sarah Wild in *Nature News* (09 November, 539, 152; 'Quest to map Africa's soil microbiome begins'). The article has generated considerable interest from researchers and organisations.

AFRICA AMBASSADOR – ISME

Dr Thulani Makhalanyane, Deputy-Director of CMEG, received the Ambassador of the Year award at the International Society for Microbial Ecology (ISME) symposium held in Montreal, Canada in 2016, in recognition of his leadership role and contribution to promoting the fields of microbial ecology and biodiversity research in South Africa. Microbial ecology is still an underdeveloped field in Africa, yet vital in the growing appreciation of the value and importance of global and regional biodiversity.



Don Cowan

FAIRY CIRCLES SOLVING ONE OF EARTH'S LITTLE MYSTERIES

The origins and causes of Fairy Circles remain mysterious; several hypotheses have been pursued but none of the explanations are confidently conclusive.

Fairy Circles are vegetation-free circular patches of soil, ranging from 2m to over 10m in diameter, surrounded by a grass matrix. These enigmatic features were, until their recent discovery in the Australian outback, thought to be endemic to the Namib Desert in southern Africa. Alternative hypotheses to explain these phenomena range from UFO landings (!), to mythical underground dragons and dancing fairies, local soil geochemistry or radioactivity, plant self-organisation and social insect ecosystem engineering activities.

Dr Jean-Baptiste Ramond and his team from the **Centre for Microbial Ecology and Genomics** of the **University of Pretoria**, and in collaboration with **Professor Don Cowan**, have their own theory. They have been investigating one of the original hypotheses, which, like UFOs and dancing fairies, has never been satisfactorily proven (or disproved). This hypothesis is that plant-pathogenic microorganisms are involved in the Fairy Circles phenomenon. The big difference in their approach is that Ramond and his collaborators are bringing the latest molecular and phylogenetic techniques to bear on the problem.

Their recent published research has proven that archaeal, bacterial and fungal communities inside Namib Desert Fairy Circles are significantly different to those outside, in the surrounding vegetated soils. They have also shown clear differences for both the Namib gravel plain and dune Fairy Circles.

Even more striking has been the discovery that over 60 different fungal species are repeatedly only found in soils inside Fairy Circles, and that many of these are affiliated to well-known phytopathogenic fungal groups (such as the *Periconia*, *Culvularia* and *Aspergillus* genera, the *Pleosporales* order, and the *Chaetomiaceae* family). This does not yet confirm that these fungi are the pathogenic *causative agents* of Fairy Circles, but it is a good start.

Ramond and his collaborators are now combining state-of-the-art functional 'omics' technologies (heavyweight techniques such as shotgun metagenome sequencing and metaproteomics), with the latest spatial ecology methods. Remote sensing drone technologies, thanks to a collaboration with researchers from the Auckland University of Technology, New Zealand, are being used to analyse Fairy Circle distribution patterns, growth rates and growth patterns – and even the thermal differences in Fairy Circles and the surrounding vegetated soils.

HOT, HOTTER, GONE?

THE IMPACT OF CLIMATE CHANGE ON DESERT BIRDS

Deserts are some of the world's most fascinating ecosystems. However, extreme temperatures and scarce rainfall make these regions highly sensitive to climate change. The risk posed by global warming calls for an urgent and concerted effort by scientists, conservationists and managers.

Diverse animals eke out an existence in harsh, inhospitable desert environments, bending the rules of chemistry and physics in remarkable ways to survive and reproduce. But life in deserts is tenuous, and rising temperatures associated with climate

change will dramatically affect the inhabitants of arid regions. Recent heat waves in Australia, for example, have led to catastrophic mortality events during which thousands of birds have perished in a matter of hours on extremely hot days.

Members of UP's **Department of Zoology and Entomology** are involved in a collaborative research programme that seeks to understand the consequences of climate change for birds that inhabit the world's deserts. The 'Hot Birds Project' came into being in 2009. Since then, it has expanded into a

sizeable research endeavour involving collaborations with local and international ornithologists, and has already seen several cohorts of students and postdoctoral fellows exploring the ways in which rising temperatures will have an impact on birds living in the arid zones of southern Africa, Australia and North America.

Professor Andrew McKechnie, Head of the Department of Zoology and Entomology at UP, leads the physiological aspects of the Hot Birds research programme. Much of this work has examined avian thermoregulation in the heat, and the thermoregulatory mechanisms that permit desert birds to avoid lethal heat stress during extremely hot weather. This work has formed the basis of a highly productive collaboration between UP and the University of New Mexico, and during 2016 led to a continental-scale assessment of the dehydration risk North American desert birds will face because of the warming predicted for the 21st century.

The behavioural component of the Hot Birds Project is steered by Dr Susie Cunningham of the Percy FitzPatrick Institute at the University of Cape Town. Many of the impacts of climate change will be manifested through subtle but consequential changes in the ability of birds to obtain sufficient food for themselves and, when breeding, for their chicks. These effects of high temperatures only become apparent through careful, intensive study of how avian behaviour changes on very hot days.

Some of the most novel and exciting research emanating from the Hot Birds Project has taken place at the interface between physiology and behaviour. For instance, in 2013 the team received a grant from the USA's National Science Foundation to develop a conceptual framework for rapid assessments of how vulnerability to climate change varies among species making up desert bird communities. This work led to a current project where **Matthew Noakes**, a PhD student at UP, used outdoor aviaries to translocate birds from cooler areas to the Kalahari in order to test hypotheses about their capacity to handle hotter conditions than they currently experience.



Erecting aviaries in the Kalahari.

Andrew McKechnie

A global partnership

During 2016, the Hot Birds Project involved collaboration between UP and several local and international universities: the University of Cape Town and the Nelson Mandela Metropolitan University in South Africa; the Universities of New Mexico, Nevada and Massachusetts in the United States; the University of Regina in Canada; and the Universities of Western Australia and Adelaide in Australia.

Science, conservation and management

Several aspects of the research undertaken by the Hot Birds team concern issues related to conservation and management. For instance, isotopic tracers have been used to elucidate how birds use isolated waterholes in desert landscapes. Members of the team have also investigated the effects of shade availability on drinking behaviour in hot weather, information that is potentially valuable in the context of managing arid areas in ways that would mitigate the impact of climate change on birds and other animals.



Andrew McKechnie



Burchell's Sandgrouse - Ben Smit



SOIL EROSION A CRITICAL ENVIRONMENTAL ISSUE

Soil erosion and the associated land degradation are critical environmental issues that hinder agricultural development and long-term ecological and agricultural sustainability.

Modelling erosion potential at a catchment or on a larger scale helps in predicting erosion hazard, particularly under changing climate and land-use scenarios.

Professor Paul Sumner in the **Department of Geography, Geoinformatics and Meteorology** is part of a team of researchers and postgraduate students who are investigating soil erosion phenomena in South Africa, southern Africa and on the island of Mauritius. He works closely with colleagues at other universities in South Africa and in the Agricultural Research Council, and at the University of Mauritius and the Mauritius Wildlife Foundation.

On Mauritius, erosion assessment has centred on modelling erosion rates on the island. Model accuracy is dependent on complete assessments of land use, soil characteristics and rainfall erosivity. While team members at the University of Mauritius have focused on erosion risk assessments, South African researchers and postgraduate students have detailed the rainfall erosivity characteristics. These

projects have developed detailed rainfall attributes for more accurate erosion modelling. In a separate study, together with the University of Mauritius and the Mauritian Wildlife Foundation, gully phenomena on an offshore islet, Round Island, have been mapped at a site where severe erosion provides a challenge in ecological restoration of a nature reserve. Such assessments help in understanding erosion processes and facilitate the rehabilitation of degraded areas.

In South Africa, the focus has been on mapping erosion phenomena and measuring the rates of gully expansion. Work has also been undertaken in the southern African region on the extent of sheet, rill and gully erosion. Three studies in South Africa have focused on gully conditions: in Mpumalanga, by contrasting the biophysical and land-use factors on gully development; in the Eastern Cape, by establishing historical erosion patterns and sediment yields in a catchment where erosion can result in rapid sedimentation of a proposed dam site; and in the upper Tugela catchment, KwaZulu-Natal, by tracing gully growth initiated as a result of infrastructure development. Such projects make possible the correlation between land use and erosion patterns.



MOUNTAIN ANTS AS BIOINDICATORS

Understanding the effects of temperature change on the diversity and activity patterns of ants is a continent-spanning research project that collects data on abundance, body size and colouration, and on the internal physiology of mountain ants.

Invertebrates, especially ants, are useful bioindicators as they are sensitive to environmental change. **Dr Tom Rhys Bishop** and **Professor Mark Robertson** in the **Department of Zoology and Entomology** study the lives of ants in mountainous regions to gain a better understanding of global patterns in biodiversity. Over several years they have used a research site in the Sani Pass of the Maloti-Drakensberg Mountains and, in 2016, made two important advances in understanding how temperature may limit the diversity and activity patterns of ants.

The first step was to gather information on the abundances of different ant species at different elevations (from 900 to 3 000 metres above sea level) in the Sani Pass, and to supplement this with data on the body size and colour of each ant species. The project was extended to collaborators in South Africa, Argentina and Australia to generate a continent-spanning dataset of ant abundance, body size and colouration.

A key finding was that in cold environments, the most common ants tended to have larger bodies and darker colours while in warmer temperatures, the most common ants were smaller and paler. These findings make sense in terms of how ants are thought to regulate body temperature. Large bodies help retain heat due to the small surface area to volume ratio, while dark colours absorb more incoming solar radiation than lighter colours. As a result, it is beneficial to have a large body and a dark colour in cold climate conditions. This advantage is so strong that the dominant ants at a given site change, depending on the environment: large, dark ants prevail in colder years while the smaller and paler ones are much more common in the warm years.

Bishop and Robinson's second area of interest has been whether the internal physiology of ant species occupying different elevations matches the temperature regimes that they experience. In order to address this question, and working in the Sani Pass at highland and lowland sites with collaborators from the United Kingdom and Australia, they collected data on the upper and lower thermal limits of a range of ant species.

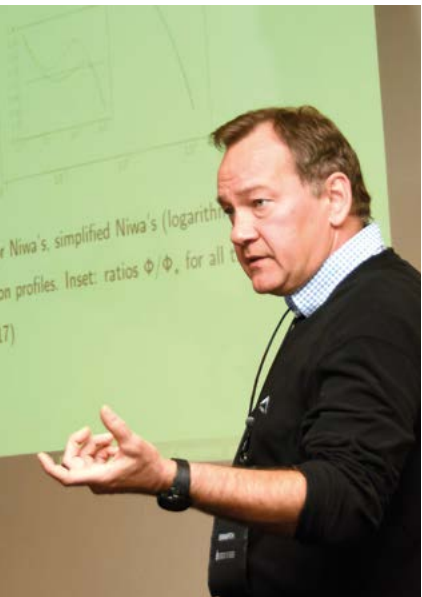
There were several interesting findings. They found that the average lower temperature limit of ant species decreased with increasing elevation. Ants occupying the cold mountaintop also had an internal physiology to match. When the researchers linked these estimates of thermal physiology to activity patterns through time, they found that ants that have adapted to withstand the cold were not influenced by changing temperatures over the years and seasons. The activity of ants that could not cope with low temperatures, however, was limited to periods when it was warm. Their research shows that it is the ability of ants to adapt to cold conditions that drives patterns of ant activity in this mountain environment, a result that has important implications for understanding the possible impacts of climate change in mountain ecosystems.



Mark Robertson and Tom Rhys Bishop

MATHEMATICAL MODELLING FOR BIOLOGICAL SYSTEMS

Mathematical modelling is often understood as statistical analyses of available data and inferences, based on the correlations found. However, correlations are not causations: they are based on assumptions that have to be tested.



Professor Jacek Banasiak, Chair of the DST-NRF South African Research Chair Initiative (SARChI) in **Mathematical Models and Methods in Bioengineering and Biosciences (M³B²)** at UP, writes that there is a tendency to treat the results of modelling as universally valid whereas they are always conditional on the assumptions made while building the model. He cites a ‘spectacular example’ of a failure to understand the assumptions of a model, in the history of the Long Term Capital Management hedge fund, whose Board of Directors included Myron S Scholes and Robert C Merton, who shared the 1997 Nobel Memorial Prize in Economic Sciences. Their basis of operation was the famous Black-Scholes equation for determining the

value of derivatives. Initially successful, with annualised returns of over 40%, the hedge fund lost \$4.6 billion in 1998 in less than four months following the 1997 Asian financial crisis, and in 1998, the Russian financial crisis. The reason for the collapse was that the Black-Scholes model requires that the market fluctuations be small and this assumption failed during large crises.

Banasiak’s point is that while mathematical models are indispensable tools for cheaply testing various scenarios in engineering, or in the natural, medical, economic or social sciences, they only give simplified descriptions of real-life problems and should not be used without understanding their limitations.

A field where mathematical modelling has been highly successful is in population dynamics, where models can be used to predict the size of populations in future. The development of the population models is a good example of the iterative process of modelling. The first population model, attributed to Thomas Malthus (*An Essay on the Principle of Population*, 1798) is the so-called exponential or geometric growth model, which correctly predicts development of many populations, as long as there is an abundance of resources to support their growth.

The model predicts fast growth of large populations, which contradicts the observation that the growth of such population slows down due to resource constraints and overcrowding, a shortcoming that was remedied by Pierre François Verhulst who in 1844–1845 introduced the so-called logistic model. As required by the principles of good modelling, the model agrees with the Malthus model for small populations, predicting their exponential growth. Large populations, however, display much slower growth, finally reaching a stable population size that is referred to as the carrying capacity of the environment. The Verhulst model has been highly



Christian Pirik

DISEASE PATHOGENICITY



The Allee effect is particularly important in epidemiological modelling as the introduction of a disease into a population increases the burden it faces and may push the survival threshold above the current size of the population, resulting in its extinction.

In this context, Dr Salisu Garba (left) has collaborated with Professor Alun Lloyd at the North Carolina State University (NCSU), United States. In work recently published, their focus is on the dynamical behaviour of an epidemiological model, with results underscoring earlier findings that the Allee effect and infectious disease are some of the extinction drivers of populations. The study

investigated the combined impact of the Allee effect and infectious disease at higher population levels, to determine which species are most vulnerable to extinction. Their research, using the susceptible-exposed-infectious (SEI) model, shows that the Allee effect, combined with disease pathogenicity, has a detrimental impact on the dynamics of a population at high population levels.

The value of epidemiological models in predicting the Allee effect was clearly demonstrated. For instance, it is well known that highly pathogenic species can cause their own extinction but not that of their host. They found that there were two thresholds, one being the carrying capacity beyond which the population cannot grow, while the other is the survival threshold that determines the minimum size/density of the population that allows it to survive.

successful in many other branches of science and engineering in modelling processes with a saturation effect.

Despite its successes in describing the mitigating effect of the size of the population on its growth, the Verhulst model does not capture the perils facing small populations. In 1931, Warder Clyde Allee observed that many populations have a window of sizes within which they can survive – they cannot grow too large lest they overexploit the resources, and they perish if they decrease below a certain survival threshold. The latter can happen due to insufficient capacity to collect food or to organise a defence against predators or, on an evolutionary time scale, due to too small a pool of mutations allowing for adaptation to changing environments.

SOCIAL PARASITISM IN HONEYBEES

Studying the behaviour and chemical communication of social insects (ants, wasps, bees and termites) leads to insights into social cohesion, hierarchies and reproductive dominance in colonies of these insects. Researchers at UP have shown how bee colonies rapidly decline and die when infested by *capensis* parasitic workers.

The work of Dr Abdullahi Yusuf (right) includes studies of the pheromones of sub-species of African honeybees, their conservation, population genetics as well as pathogens that affect them. As one of the principal investigators within the M³B² SARChI Chair, together with colleagues, Dr Yusuf is using mathematical models to understand the population dynamics of honeybee colonies under normal conditions, and also when they are challenged by diseases and parasites.

There have been substantial colony losses as a result of infestation by social parasitic bees that are endemic to the Cape region of southern Africa. Dr Yusuf’s modelling has explored the dynamics of the changing composition of the workers in an infected colony with the decline of host workers and the increasing numbers of social parasites, which result in significant losses of colonies in apiaries, a phenomenon called the Capensis Calamity.



PARTY AFTER DARK A TALE OF TWO SHREWS

Light and the day-night transition is crucial in the reproductive and life history processes of many organisms and particularly mammals; and so do activity patterns linked to seasonal changes make possible sympatric coexistence.



Forest shrew – Marietjie Oosthuizen

Carol Hoole, under the supervision of Professors Nigel Bennett and Andrew McKechnie in the Department of Zoology and Entomology, has been unravelling how the natural environment can shape the reproduction and activity patterns of two shrew species in the eastern Cape.

Photoperiodism is the process by which organisms use both absolute measures of day length, and the direction in which day length is changing, as a cue for regulating seasonal changes in physiology and behaviour so that birth and lactation arise with optimal resource availability, thus increasing offspring survival. Two sympatric shrew species were studied to assess how the length of a day affects the reproductive biology of males: the Red musk shrew, *Crocidura flavescens* ($\pm 40g$) and the Forest shrew, *Myosorex varius* ($\pm 10g$). Interestingly, the Red musk shrew, an insectivore with a longer lifespan than the heterospecific Forest shrew, was found to exhibit reproductive activation on a short day, where males exhibited greater testicular volume and seminiferous tubule diameter following exposure to a short day, but long night cycle. This suggests that these animals may have breeding peaks that correspond to short days. In

direct contrast, the short-lived Forest shrew was found to show increased testicular volume and seminiferous tubule diameter on a long day.

The day-night cycle is also important for dictating the locomotory activity patterns of organisms. Again, the two sympatric species of shrew placed in the laboratory on a 12-hour light/12-hour dark light cycle exhibited a strictly nocturnal activity pattern with polyphasic periods of activity occurring in the dark phase of the light cycle. The smaller Forest shrew exhibited greater frequency of polyphasic energy due to higher energy demands. When the shrews were trapped throughout the year in the field, the smaller Forest shrew were found to be captured mainly at night well after sunset in the summer, spring and autumn months, whereas captures in the winter months were at dawn and dusk, with individuals avoiding the very cold nights. In direct contrast, the larger Red musk shrew maintained a very strict nocturnal activity pattern with captures occurring well into the night. These studies again show that the smaller shrew maintains its activity to avoid times that could result in hypothermia, and potentially to avoid competition as the larger Red musk shrew will feed on the smaller Forest shrew.

These two studies elegantly demonstrate how two species of differing lifespan and body size organise their reproductive biology and locomotory activity patterns in unison with the changes in day length and seasonal changes in temperature to enable a sympatric coexistence.

A TRIBUTE TO A LIFETIME'S RESEARCH



The legacy of scientific research at the Prince Edward and Marion Islands, and the many individuals who have contributed to research in this remote context, is captured in a book compiled and edited by Nico de Bruyn and Chris Oosthuizen, *Pain forms character: Doc Bester, cat hunters and sealers* (Antarctic Legacy of South Africa, 2017). The book is dedicated to Professor Marthán N Bester for his contribution to science and conservation, and his influence on generations of young and fellow researchers. Bester's 40-year 'island research' career, through the South African National Antarctic Programme (SANAP), and the Marion Island Marine Mammal Programme (MIMMP) which he started in 1983, provides rich context for this tribute to his life's work. The book does what the substantial scientific literature and research outcomes do not: it provides personal accounts of the harsh working and living conditions, and the marvelous camaraderie, of the Marion Island 'cat-hunters' and 'sealers'.



Elephant seal – Nico de Bruyn

MARINE MAMMALS AND ENVIRONMENTAL CHANGE

Marion Island, far removed from any human encroachment and teeming with animal life, forms part of the Prince Edward Islands archipelago, situated about halfway between South Africa and Antarctica. Under South African legislation, the archipelago is a 'Special Nature Reserve', holding the highest level of protective status and set aside solely for the purposes of biodiversity conservation and research.

For more than three decades, Marion Island has been the base of the Marion Island Marine Mammal Programme (MIMMP), a research programme of the Mammal Research Institute at UP. The island is home to unique flora and fauna and is the terrestrial base of three species of seals: the southern elephant seals *Mirounga leonina* (SES), the Subantarctic fur seals *Arctocephalus tropicalis* (SAFS), and Antarctic fur seals *Arctocephalus gazella* (AFS), as well as of the resident killer whales *Orcinus orca* (KW).

Professor Nico de Bruyn leads a small and highly dedicated team that studies these marine mammals. An important current research activity is to measure the response of these mammals to environmental change. Over the past 34 years, originally led by Professor Marthán Bester and now by Professor de Bruyn, these teams have undertaken a long-term census of population numbers, and developed an understanding of the complex interactions between predator, prey and the marine environment.

The long-term nature of the studies has also opened up many research avenues. For example, researchers have been studying the tendency of individual

southern elephant seals to repeatedly use the same foraging areas, particularly in unpredictable environments, by using satellite tracking and diving data from multiple winter migrations. These data provide clues to the adaptability of elephant seals to rapid environmental change.

Subantarctic islands are sensitive to environmental change because of their comparatively simple ecosystems. Through the uninterrupted southern elephant seal mark-recapture experiment, and the continued use of satellite-linked tracking devices on elephant seals, fur seals and killer whales, the research team has uncovered factors that drive large mammal population dynamics and how these link to a changing environment. Populations of most of Marion Island's precious marine mammals are steadily rising, despite a steadily warming subantarctic climate. However, recent evidence of pup production trend change in one species, the abundant SAFS, is again testing our understanding of the ecology of these top predators and their ecosystem and underscores the importance of continued investigation.



FABI

PLANT PRODUCTION AND FOOD SECURITY

This theme highlights areas where UP is at the forefront of creating new knowledge on pests and diseases of plants relevant to Africa, building research capacity and networks, and developing new innovations for pest management. The examples include research on diverse systems such as tree-associated fungi and insects, and pests of maize, tomato, potato and fruit crops. This theme also addresses the vital role of bees as pollinators of both native flora and agriculturally important crops, and the threats to honeybees and other pollinators. Finally, two profiles of UP researchers who focus on invasive species and their threats to biodiversity and the economy, are included.

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PLANT HEALTH IN AN INTERCONNECTED WORLD

“The 2030 Agenda for Sustainable Development, as well as the Paris Agreement on climate change, recognise that we can no longer look at food security and the management of natural resources separately. Both agreements call for a coherent and integrated approach to sustainability across all agricultural sectors (including forestry) and food systems.”¹

The University of Pretoria’s research strength in biotechnology for plant health management, and its capacity to develop human capital in this domain, represent a resource of critical importance for the future development of Africa, as well as for safeguarding its current systems and rich biological resources.

Plant health is a key priority for the attainment of a number of the goals identified in the United Nation’s Sustainable Development Goals (SDGs), the African Union’s Agenda 2063, and South Africa’s National Development Plan 2030. This is because plant health is essential for human health, economic growth and decent work, the eradication of hunger and poverty, and safeguarding the environment and natural resources.

The ecological transformations brought about by climate change and globalisation are escalating plant health problems to a level that is almost unmanageable. For example, before the mid-1980s new forestry insect pests emerged at a rate of about one per decade, but now appear roughly every 1.4 years. In agriculture, the situation is worse. The fall armyworm, a pest of maize and other cereals, spread from Nigeria to South Africa in less than a year. If uncontrolled, it could decimate staple crops throughout Africa and cripple agriculture on the continent. Compared to insect pests, the rate at which new microbial pathogens emerge and spread is even higher.

Because of these problems, most of the production systems that we rely on for our food and fibre needs are failing, and fragile natural ecosystems are collapsing. Industries and governments worldwide are grappling with ways to deal with the crisis.

One solution that features prominently is biotechnology. We live in an era where biotechnological tools and innovations provide unprecedented power to understand the organisms affecting plant health, the mechanisms through which plants respond to these, the pathways by which these organisms move, and points in the system (from genes to logistics) that can be manipulated to reduce the impact. Emerging opportunities in tools such as genomics, gene editing and ‘reverse’ chemical ecology, to name but a few, provide powerful opportunities to ensure that we optimise our ability to manage the emerging plant health problems threatening our environment and society.

In an ever-changing and interconnected world, local solutions on their own can no longer deal with plant health problems. Much greater focus needs to be placed on developing global strategies to monitor pest and pathogen movement and to mount appropriate outbreak responses, as well as to fully harness the powerful opportunities that new technologies offer. Local capacity needs to be linked more effectively into international knowledge networks. Similarly, partnerships between the research community, industries, government and societies, in general, will need to be stronger than ever.

¹ UN Food and Agriculture Organisation Director-General, José Graziano da Silva



FABI

SUSTAINING WOODY ECOSYSTEMS AND PLANTED FORESTS

Collaboration between the **Tree Protection Cooperative Programme (TPCP)** and the **DST-NRF Centre of Excellence in Tree Health Biotechnology (CTHB)**, based at the **Forestry and Agricultural Biotechnology Institute (FABI)** at UP, represents a long-term industry-government-university partnership that uses biotechnology to promote the health and sustainability of trees.

In order to promote and achieve the vision of ‘keeping trees healthy’, the TPCP-CTHB undertakes research across a broad suite of disciplines, including genetics, microbiology, entomology, genomics, plant pathology, ecology, biostatistics, biochemistry and chemistry. TPCP-CTHB projects typically span diverse topics, ranging from tree health surveillance, through to the control or containment of microbial diseases and insect pests, by using biotechnological approaches and biological control. To inform management and policy decisions at national, regional and international levels, the TPCP-CTHB also investigates the effect of factors such as climate change, fire, drought and human activity on our woody resources and ecosystems.

In 2016 alone, the TPCP-CTHB showcased its research output in 94 articles in international peer-review journals, and continued to use the knowledge generated to develop and implement practical disease and pest control applications that save the forestry industry millions annually. The group also continued to assist the South African government in developing and implementing national strategies and legislation concerning the health of trees and woody ecosystems.

The primary catalyst for the success of the TPCP-CTHB is its strong human resource base. The 2016 team included 115 postgraduate students whose research activities and training were guided and facilitated by a team of 33 scientists and 18 highly talented postdoctoral researchers from a variety of academic backgrounds and nationalities. The TPCP-CTHB thus draws on large multidisciplinary research teams to tackle difficult tree health problems with the ultimate goal of safeguarding South Africa’s woody resources.



Emma Steenkamp (right), Professor in the Department of Microbiology and Plant Pathology, and Deputy Director of the CTHB, with six talented postdoctoral fellows.

MYCOLOGY AS A FIELD OF EXCELLENCE IN AFRICA

Fungi are critical to our world: from bread, wine and other foods we eat, to causing devastating diseases of plant and animals (including humans), to being the primary decomposers of the biological debris of our world.

Professor Wilhelm de Beer writes that for those interested in the field of mycology for study and research, the University of Pretoria is one of the top places in the world to do so. A recent analysis by the Center for World University Rankings (CWUR) places UP second with respect to its subject rankings

among the world's leading universities. In the field of mycology there are several reasons for this achievement: the critical mass of research capacity in FABI and the strong international collaborations with good scientists from many countries around the world, high levels of research productivity, and a highly successful leverage-based funding model. Together, this model ensures a stable base of funding over the long term. In addition, research facilities with world-class laboratories and infrastructure, provided by the University of Pretoria, all help to create an environment conducive to world-leading research.



Above: Some of the mycology researchers at FABI.

Right: The fungus culture collection falls under the portfolio of Wilhelm de Beer, and is curated by Dr Seonju Marincowitz (left), with assistance by Lydia Twala and Valentina Nkosi (not shown).



THE LARGEST FUNGUS CULTURE COLLECTION

FABI houses the largest fungus culture collection in Africa, and one of the largest in the world. The research collection of about 4 000 fungal isolates of Professor Mike Wingfield formed the foundation of the collection when FABI was established in 1998. It has since grown to more than 50 000 isolates, mostly related to tree disease, and is an absolutely indispensable resource for the mycological research conducted at the Institute.

SYSTEMS GENETICS UP RESEARCHERS UNRAVEL GENE NETWORKS

Systems genetics is an experimental and statistical approach to understanding the dynamics and interactions of genes and biological processes that act together to give rise to complex trait variation in plant and animal populations.

In 2016, two research groups, in the **Department of Genetics** and in the **Department of Plant and Soil Sciences**, pioneered the use of systems genetics to study the woody biomass production in *Eucalyptus* trees, and foliar disease interactions in maize. Experimental and statistical methods were used to analyse and integrate molecular component phenotypes, such as gene expression, and protein or metabolite levels, in populations that vary for these components and for complex traits such as growth, development and defence.

These studies featured the work of two young researchers, **Dr Eshchar Mizrahi** and **Dr Nanette Christie**, who have been instrumental in establishing the underlying genomics and statistical methods for analysing these two biological systems. Both



Moloko/Dallia, FABI

studies were also performed in collaboration with the Bioinformatics and Systems Biology research groups of **Professors Yves van de Peer** and **Kathleen Marchal** at Ghent University in Belgium, both of whom are visiting professors at the **Genome Research Institute** at UP.

GENE NETWORKS DRIVING WOOD FORMATION IN TREES

How trees produce vast amounts of wood, and how to change the properties of wood to suit various end uses, are questions that have been difficult to pursue in trees due to their large sizes and long life cycles.

The advent of modern genomics technologies, which enable the rapid and simultaneous profiling of thousands of genes, even in difficult to analyse tissues such as wood from mature trees, promises to overcome these hurdles. Together with their Belgian collaborators, **Dr Eshchar Mizrahi**, **Dr Nanette Christie** and **Professor Zander Myburg** in the **Department of Genetics** have reported one of the first large-scale, integrated analyses of tens of thousands of genes in developing *Eucalyptus* plantation wood. In their paper, published in the prestigious journal *Proceedings of the National Academy of Sciences of the United States of America*

(Mizrahi *et al.* PNAS, January 2017), the team described how they used network-based approaches (connecting genes with similar expression and functions) to unravel the molecular basis of wood formation.

In particular, the team pioneered the use of a systems genetics approach that leverages the power of genetics in large numbers of trees. For their project, a collaboration with industry partner Sappi, the team sampled genetic materials from developing wood of 156 *Eucalyptus* trees and profiled the expression of nearly 30 000 genes in each tree, allowing them to identify the gene networks important for the different structural and chemical properties of wood. This information can now be used for molecular breeding or genetic engineering of trees in an effort to develop a new generation of woody biomass crops supporting a thriving and sustainable bio-based economy.



Nanette Christie and Eshchar Mizrahi



Dave Berger and Zander Myburg

FUNGAL PATHOGENS AND MAIZE DISEASE

Grey Leaf Spot (GLS) disease in maize, caused by the fungal pathogen *Cercospora zeina*, can have a serious effect on maize production, often affecting small-holder farmers in South Africa, Africa and further afield.

Resistance to the fungal pathogen is thought to be a complex trait mediated by many genetic factors and biological processes. The research team of **Professor Dave Berger**, together with **Dr Nanette Christie** and **Professor Zander Myburg**, applied a systems genetics approach to unravelling gene expression networks and genetic drivers of responses to GLS infection in maize leaves.

In collaboration with industry partner PANNAR SEED Pty Ltd, the team profiled the expression of 19 000 genes in GLS-infected leaves of 100 resistant and susceptible maize lines. This analysis, reported in a leading plant science journal (Christie *et al. The*

Plant Journal), revealed exactly which genes and molecular processes were involved in susceptibility and resistance to this important fungal disease. The work lays a sound basis for the future engineering or breeding of new maize lines that will be resistant to the GLS disease.

The work forms part of the research portfolio of the Forestry and Agricultural Biotechnology Institute (FABI) and Genomics Research Institute (GRI), and was supported by the major computing infrastructure in the **Centre for Bioinformatics and Computational Biology (CBCB)**, directed by **Dr Fourie Joubert**.

GOOD AND BAD OPPORTUNISTIC BACTERIAL SPECIES

Understanding how opportunistic plant pathogenic bacteria function in different environments is central to understanding tree health.

Professor Teresa Coutinho, a member of the **Centre for Microbial Ecology and Genomics (CMEG)** and the Forestry and Agricultural Biotechnology Institute (FABI) at UP, has been leading research projects on the pathology of opportunistic bacterial species that infect *Eucalyptus* and stone fruit trees for several years. Her research group mainly focuses on four bacterial species: *Pantoea ananatis*, *Ralstonia solanacearum*, *R. pseudosolanacearum* and *Pseudomonas syringae* pv. *syringae*. In their association with woody hosts, these pathogens are all regarded as opportunistic.

Pantoea ananatis is a ubiquitous bacterium. As a pathogen it infects a number of plants across a wide geographic range, but can also associate with plants without causing a detrimental effect to their health. Some strains are even used in the agricultural sector as biocontrol agents against insect pests while others enhance plant growth. There are also strains that infect humans, causing bacteraemia. *P. ananatis* is thus regarded as an opportunist pathogen, based on its ability to survive and proliferate in such different environments.

Using a comparative and functional genomic approach, Professor Coutinho's group has aimed to determine how this bacterium can function so successfully in such diverse ecological niches, and why it is sometimes a pathogen, and sometimes not.

The two *Ralstonia* species and *Ps. syringae* pv. *syringae* are believed only to infect *Eucalyptus* and stone fruit trees, respectively, and only when they are stressed by abiotic and/or biotic factors. Poor planting practices enhance the appearance of bacterial wilt, caused by the *Ralstonia* spp., in *Eucalyptus* plantations. In a project funded by HORTGRO and in collaboration with ARC-Infruited, the role of abiotic (drought) and biotic (*Phytophthora* and the ring nematode) effects are being investigated



as factors that enhance bacterial canker in the stone fruit tree industry in the Western Cape. From extensive surveys undertaken in this province, it is evident that these factors, together with the bacterial pathogen, contribute substantially to the loss of orchard trees, particularly plums, cherries and apricots.

Symptoms of bacterial canker on the branches of an apricot tree.

IDENTIFYING DEFENCE MECHANISMS



Professor Lucy Moleleki, in the **Department of Microbiology and Plant Pathology**, is the leader of the bacterial genomics and host pathogen group in FABI. One of the research group's aims is to understand the threat posed by root knot nematodes (RKN) in the potato industry. Their focus is on *Pectobacterium carotovorum* subsp. *brasiliense* (*Pcb*), identified as the most important potato pathogen in South Africa and East Africa. Much of the current research focuses on the virulence mechanisms that *Pcb* uses to infect potato stems and tubers, as well as on defence responses in the host plant potato.

The research team has screened different potato cultivars against *Pcb* infection. While most commercially available cultivars tested were highly susceptible to *Pcb*, one of the cultivars appeared to be highly tolerant to *Pcb*. A time-course 'RNA-seq' study has revealed key differences in the transcriptomes of the susceptible and tolerant cultivars – in simple terms, the 'transcripts' that influence cell structure and regulate genes. These results offer a new route to the development of new and highly-resistant commercial potato cultivars.

STAPLE FOOD CROPS AND PATHOGENS



The potato ranks fourth, after rice, wheat and maize, as the most important human food crop worldwide. However, cultivated potatoes, like many other plants, are exposed to diverse abiotic and biotic stresses.

Since the first description of the devastating *Pectobacterium carotovorum* subsp. *brasiliense* (*Pcb*) infection of potatoes in South Africa in 2010, **Professor Jacquie van der Waals** and her research team (the Potato Pathology Programme @ UP) have demonstrated that *Pcb* is the causal agent of soft rot, blackleg and aerial stem rot on potatoes, and can cause substantial yield losses. There is no chemical control available to manage this disease complex.

Van der Waals' research has focused primarily on gaining a better understanding of the epidemiology of the disease, as well as investigating disease management options to reduce yield losses in the potato industry. She collaborates with many researchers at universities in South Africa and at the

Agricultural Research Council, and with researchers in Scotland, The Netherlands, Israel, Poland and Zimbabwe. The Potato Pathology Programme @ UP also houses a diagnostic clinic for plant diseases, specifically potato diseases.



SUSTAINABLE AGRICULTURE AND FOOD SECURITY

Food must be affordable, available, nutritious and safe for all – this is a basic human right.

Professor Lise Korsten, **Professor of Plant Pathology** at UP, and **Co-Director of the DST-NRF Centre of Excellence in Food Security**, comments that food security and safety can only be addressed through a structured approach that targets different operational levels in both the formal and informal sectors. The rapid and accurate identification and characterisation of foodborne pathogens throughout the supply chain, and the subsequent source-tracking in the water-plant-human nexus, form the core of her research programme. This is one of the flagship programmes at UP, and of the Centre of Excellence.

Despite global efforts to increase food production, and to reduce waste and losses, the UN Food and Agriculture Organisation (FAO) estimates that approximately 795 million people still suffer from hunger, and more than two billion from micronutrient deficiencies or forms of over-nourishment. Most people will also experience, at least once in their lifetime, a foodborne disease, and one in 10 will fall seriously ill while 420 000 will die annually. The UN World Health Organisation (WHO) estimates that about one-third of the 51 million deaths worldwide results from infectious and parasitic diseases. This, according to the WHO, is the global burden of foodborne diseases.

The risk of foodborne diseases is most severe in low- and middle-income countries and is directly linked to contaminated irrigation water; inadequate growing conditions or practices in food production, storage and distribution systems; the preparation of food with unsafe water; poor personal hygiene and lower levels of literacy and education; and insufficient food safety legislation or its implementation. Food safety, nutrition and food security are therefore inextricably linked and require multidisciplinary approaches to attain meaningful solutions.

Globally, the increase in antimicrobial-resistant microorganisms is one of the emerging 'hot topics' according to the WHO and has been included in

the **Plant Health and Food Safety** research programme of Professor Korsten. Her research, and that of her postgraduate students, has attracted significant external funding, notably from the European Union, the United States Agency for International Development (USAID); and partnerships with the US Department of Agriculture (USDA) and Food and Drug Administration (FDA), and the Water Research Commission (WRC) in South Africa.

Professor Korsten emphasises that Africa's agenda and the global vision to make agriculture and food systems sustainable, as expressed in several recent global and regional frameworks, will require innovation and transformative changes in research and training, technology transfer, policy and governance.

One of the key focus areas in all these visions, frameworks and agendas is to develop the policies, mechanisms and actions that will lead to the assurance that food will be safe, despite the many challenges. In the commercial agriculture and the formal food sector there is a plethora of legislation that relies too often on self-regulated food safety standards, while a major gap exists in the unregulated informal sector, especially in developing regions and rural areas.



SA Perishable Produce Export Certification Agency

CENTRE OF EXCELLENCE – FOOD SECURITY

The DST-NRF Centre of Excellence in Food Security (CoE-FS) is jointly hosted by the University of Pretoria and the University of the Western Cape (UWC). The Centre is a virtual organisation that brings together the expertise of numerous South African and international institutions, and over 100 researchers across several disciplines. Since its establishment in 2014, a targeted approach to food security research has been followed within six priority research areas. An integrated framework has also made possible a continued focus on the causes, contexts and consequences of food insecurity, especially for poor and vulnerable populations in a changing food system.

The CoE-FS is led by Professor Julian May (Director) who is based at UWC, and Professor Lise Korsten (Interim Co-Director) at UP.

FOOD AND BIODIVERSITY

THE ROLE OF BEES

Honeybees are major pollinators of both native flora and agriculturally important crops and therefore significantly contribute to conserving natural habitats and biodiversity.

The work of the **Social Insects Research Group (SIRG)** on honeybees has been prescient in that there has been a growing appreciation for the dependence of human populations on the food provided by the fruits and crops pollinated by honeybees.

Honeybees and other pollinators are threatened by several factors. These include parasites such as mites, pathogens (for example, American foulbrood), landscape and climate change. These factors have an impact on the wild population of honeybees and affect the agricultural sector and threaten food security and biodiversity. Even worse, the effects on the wild population of honeybee and other pollinators are poorly understood. In order to address the concerns about honeybee population welfare, researchers at UP are studying the epidemiology of bee diseases and parasites and are monitoring the population densities of honeybee

colonies in undisturbed habitats to establish what fluctuations are occurring in the wild population of colonies. Central questions are: what is a healthy and balanced diet for bees, and how are pesticides undermining the health of bees?

Understanding the dynamics of wild populations will provide an answer regarding declining honeybee populations, at least on the African continent. It will also show the contribution of honeybees to biodiversity, food security and the pollination services they render to the agricultural sector.

The work undertaken by members of the group ranges from investigating bee diseases and parasites; exploring the chemical ecology of relationships between queens and workers through the use of pheromones in populations of honeybees throughout the African continent; analysing the

genes responsible for the expression of a variety of social behaviours; and assessing population densities and distribution within South Africa. Moreover, research foci have included the contribution of honeybee pollination to crop yield; how the available forage (pollen and nectar) affects honeybee health; and exploring honeybee nutritional physiology in order to understand their ability to withstand pesticides and toxins in the agricultural environment.

The Social Insects Research Group is the largest and most active group in the field of honeybee research in southern Africa. The group also investigates basic behavioural and chemical ecology questions by using other systems such as mosquito-borne diseases. To address the problem of global honeybee health and colony losses, the group has joined COLOSS (Prevention of Honeybee COLony LOSSes) and SUPER-B networks that focus on improving



Christian Pirk

the wellbeing of bees and pollinators at the global level. The group has, since 2015, been a member of the Executive Council of the Africa Apiculture Platform (AAP) for honey production, bee health and pollination services of the African Union.

Members of the SIRG are Professors Christian Pirk, Robin Crewe, Sue Nicholson, and Drs Abdullahi Yusuf, Hannelie Human, Ezette DuRand, Sandra Mustafa and a vibrant group of PhD and MSc students.



Botterblomme – Adriaan Oosthuizen

UNDERSTANDING INVASIVE SPECIES

Climate change and the impact of people on the environment is an important theme in several research areas at the University of Pretoria. Two examples are given here of the work of young researchers who, in partnerships with international scholars, have focused their work on the introductions of species into areas to which they are not indigenous, posing a serious threat to biodiversity and to the economy.

IDENTIFYING PRIORITIES TO PREVENT THE INTRODUCTION OF INVASIVE SPECIES

With the increasing movement of goods and people around the world, organisms are introduced to regions where some become invasive with negative ecological and socio-economic impacts.

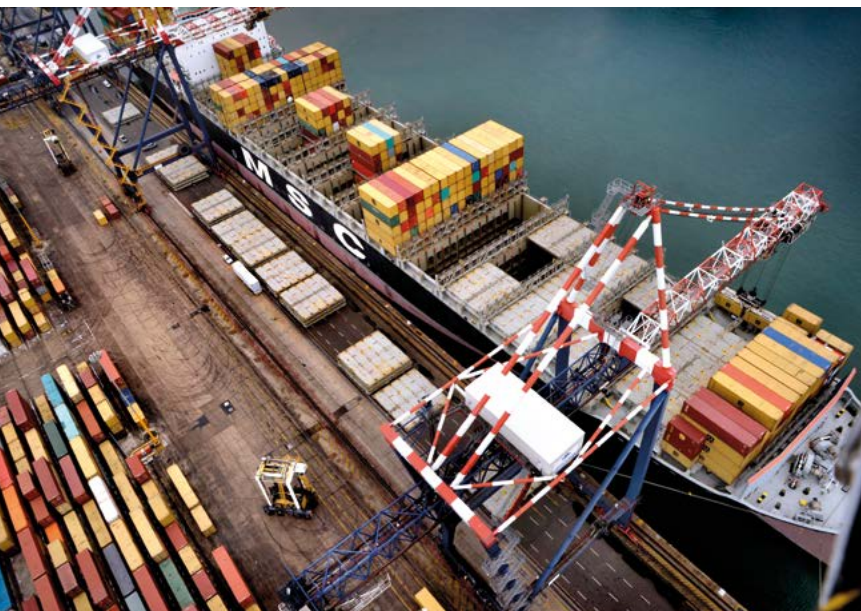
The number of alien species introduced to South Africa has increased over time. Often the most cost-effective ways of dealing with alien and potentially harmful organisms is to prevent their introduction, which requires the implementation of effective biosecurity measures.

Dr Katelyn Faulkner and Professor Mark Robertson in the Department of Zoology and Entomology,

with Professors Mathieu Rouget (CIRAD, La Réunion) and John Wilson (Centre for Invasion Biology, Stellenbosch University), are attempting to identify species that are likely to be introduced (future aliens). The value of their research is in providing information that can be used to identify priorities, and to direct action and resources to prevent the introduction of potentially harmful alien organisms. To this end, they have been involved in the development of a watch list of invasive species for South Africa. Species on the watch list include the southern house mosquito (*Culex quinquefasciatus*), which is a vector of human and animal diseases such as the West Nile virus and Avian malaria, and the Asian tunicate (*Styela clava*), a marine invertebrate that competes with local and aquaculture species.

They have also established that a large number of alien species are transported to South Africa on ships. Their results suggest that the Durban port, in particular, needs to be targeted with biosecurity measures as it is likely to be the recipient of the highest number of these alien species. It is South Africa's busiest port and is environmentally similar to many of the ports from which visiting ships travel.

The watch list they have developed is currently being used by the Biosecurity Unit of the Department of Environmental Affairs. They are also contributing to the first National Status Report on Biological Invasions (due to be finalised in 2017), which will provide information on the extent and impact of biological invasions and the effectiveness of interventions.



Transnet

INVASION BIOLOGY AND THE STUDY OF FLIES

As global temperatures rise, the threat of invasive insect species is expected to increase as insects expand their range into temperate areas. In this context, the ability of flies to withstand desiccation is likely to contribute to their invasive potential.

Dr Chris Weldon leads a research group in the Department of Zoology and Entomology, dedicated to the study of flies of economic significance – the FliES research group. He and his team work on the behaviour, ecology and physiology of diverse fly species, including fruit flies, blow flies and mosquitoes, among others. Their objective is to optimise the management of flies by understanding their biology.

His recent research has addressed how three pest fruit fly species cope with dry conditions. He found that the Mediterranean fruit fly, a species from Africa but now a global pest of fruit production, is highly resistant to desiccation due to low water loss rates and the ability to release water by breaking down fats stored in its body. The marula fruit fly, *Ceratitis cosyra*, which develops in marulas but is also a major pest of mango production, was also highly resistant to water loss, but its distribution is limited by the availability of its fruit hosts. The Natal fly, *Ceratitis rosa*, is not particularly resistant to desiccation and suffers high rates of water loss during dry, warm conditions, which explains its restricted distribution to humid coastal regions. These results suggest that *C. capitata* and *C. cosyra* are unlikely to be greatly affected by the warming, drying conditions expected in southern Africa as a result of climate change.

A recently discovered new fruit fly species, the Oriental fruit fly (*Bactrocera dorsalis*), was first detected in Kenya and has now spread through most of sub-Saharan Africa. Its presence is particularly alarming because it targets fruits as well as vegetables. Dr Weldon's research group is researching this species to obtain a better understanding of its dispersal and the susceptibility of commercial food and vegetable production to this pest.



Mediterranean fruit fly, *Ceratitis capitata*.

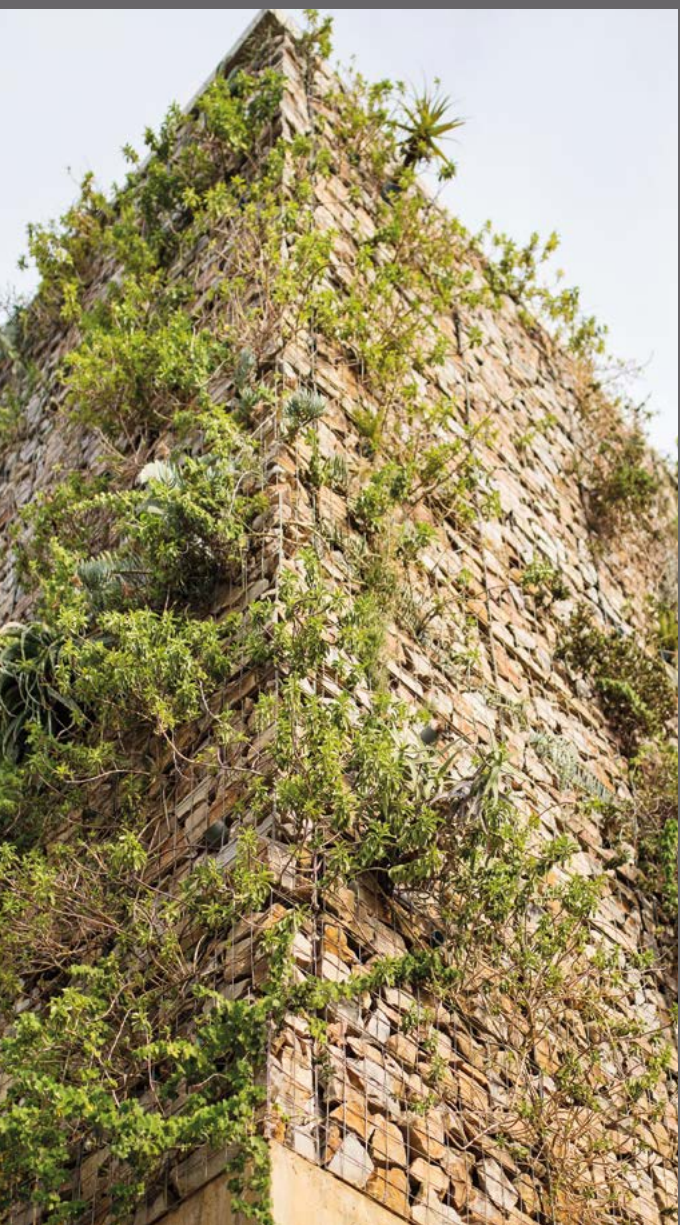
André Coetzer

CS FLIES

Other than their importance in agriculture, flies are also useful in crime investigations.

Postgraduate research under Dr Weldon's supervision has focused on the use of blowflies as evidence in forensic investigations, as the presence and developmental stage of blowfly species on a corpse can provide information on the approximate time of death. For her Master's research, Zanthé Kotzé found that estimates of *post-mortem* interval must take larval aggregation size into consideration because larger groups of larvae accumulate metabolic heat and develop faster as a consequence. Nina Parry established in her Honours research that there were differences in the distribution and abundance of carrion-associated flies in different habitat types in the City of Tshwane, which may prove useful in determining whether a body has been moved *post-mortem*.





Lucinda du Toit

AWARDS AND ACHIEVEMENTS

UP

research
rewarded

In concluding this Review, we acknowledge lead researchers at the University, recognised for their excellence in 2016. We do so by listing the main UP research awards presented at the annual Academic Achievers' Awards event, and some of the most prestigious external awards received by researchers at UP. This is followed by short profiles on the 15 A-rated scientists at UP who are recognised as international leaders in their respective fields. A final brief comment on new developments in 2016 is followed by a note of acknowledgement to all who have contributed to this retrospective review of research at UP.

AWARDS AND ACHIEVEMENTS

INTERNAL UP AWARDS

Each year the University honours and celebrates researchers and academic achievers for their scholarly contributions. There are five categories: the Chancellor's Award, the Vice-Chancellor's Book Awards, the Exceptional Postgraduate Supervisors' Award, and awards for exceptional academic achievers, and exceptional young researchers.

The Chancellor's Award: Teaching and Learning

Professor Tania Hanekom, Department of Electrical, Electronic and Computer Engineering, was the recipient of this prestigious award for 2016, in recognition of her noteworthy achievement and contribution to the development and practice of excellence and innovation in engineering teaching and learning.

The Vice-Chancellor's Book Awards

The Vice-Chancellor's Book Awards recognise and reward authors of scholarly books, monographs and collections. The prizes are awarded annually in two categories, the Humanities and Social Sciences, and Natural and Applied Sciences. For 2016, the award for the Humanities and Social Sciences was made to **Professor Charles van Onselen** for his book titled: *Showdown at the Red Lion: the Life and Times of Jack McLoughlin*.

Exceptional Postgraduate Supervisors' Award

Professor Nigel Bennett was the recipient of the Exceptional Postgraduate Supervisors' Award for 2016, in recognition of his excellence as a supervisor. He is a Professor of Zoology at UP and is also the incumbent of the South African Research Chairs Initiative (SARChI) Chair in Mammalian Behavioural Ecology and Physiology, and of the Austin Roberts Chair of African Mammology.

Exceptional Academic Achievers Awards

These awards recognise senior academics who are regarded highly by their peers and have consistently excelled in the areas of under- and postgraduate teaching and learning, research, community service and administration. For the year 2016, there were 10 awards: **Prof Roumen Anguelov** (Head of Department, Mathematics and Applied Mathematics) **Prof Ian Craig** (Group Head: Control Systems in the Department of Electrical, Electronic and Computer Engineering) **Prof Jaco Greeff** (Department of Genetics) **Prof Josua Meyer** (Head of Department, Mechanical and Aeronautical Engineering, and Chair of the School of Engineering) **Prof Zander Myburg** (Department of Genetics, and Chair of Forest Genomics and Biotechnology) **Prof Robert Pattinson** (Director of the South African Medical Research Council's Maternal and Infant Health Care Strategies Unit

in the Department of Obstetrics and Gynaecology)

Prof Jolanda Roux (Forestry and Agricultural Biotechnology Institute (FABI), Department of Plant and Soil Sciences)

Prof Johan Schoeman (Head of the Department of Companion Animal Studies, Veterinary Science)

Prof Fanus Venter (Department of Microbiology and Plant Pathology and holder of the Rand Water Chair in Water Microbiology)

Prof Alexander Zimper (Department of Economics).

Exceptional Young Researchers

This award is given to exceptional young researchers. Six awards were made for the year 2016:

Prof Stephen Coetzee (Department of Accounting in the Faculty of Economic and Management Sciences)

Prof Vinet Coetzee (Department of Genetics, and principal investigator of the Facial Morphology Research Group)

Dr Martina Crole (Department of Anatomy and Physiology, Faculty of Veterinary Science)

Dr Brett Hurley (Department of Zoology and Entomology, and a research leader of the Tree Protection Cooperative Programme (TPCP), and the DST-NRF Centre of Excellence in Tree Health Biotechnology (CTHB) at the Forestry and Agricultural Biotechnology Institute (FABI))

Dr Reza Malekian (Department of Electrical, Electronic and Computer Engineering in the Faculty of Engineering, Built Environment and Information Technology)

Dr Alisa Phulukdaree (Department of Physiology in the Faculty of Health Sciences).

EXTERNAL AWARDS

Multiple awards and honours were presented to many academics across the University for excellence in their disciplines and fields, both nationally and internationally. Some of the most prestigious include:

Prof Chabani Manganyi, Research Fellow at the Centre for the Advancement of Scholarship, received the NRF Lifetime Achievement Award for his extraordinary contributions to the development of science in and for South Africa.

Prof Brenda Wingfield, holder of the SARChI Chair in Fungal Genomics, was awarded the Harry Oppenheimer Memorial Fellowship Award for 2016.

Prof Mike Wingfield, Founding Director for the Forestry and Biotechnology Institute (FABI), received the Distinguished Leadership Award for 2016 from his alma mater, the University of Minnesota. He also received the 2017 John FW Herschel Medal of the Royal Society of South Africa in recognition of his highly distinguished multidisciplinary contributions to science.

Prof Stella Nkomo received the Continental Lifetime Achiever



Back (from left): Thabo Shingange and Henrico Barnard (SRC), Prof Charles van Onselen and Prof Tania Hanekom. Front (from left): Dr Molapo Qhobela (CEO NRF), Dr Khotso Mokhele (guest speaker), Prof Stella Nkomo, Prof Cheryl de la Rey (Vice-Chancellor and Principal), Prof Stephanie Burton (Vice-Principal), Mr Piet Botha (Vice-Chair of Council), Barbara-Ann Ribeiro (Council), and Prof Tinyiko Maluleke.

Award in the CEO Global Africa’s Most Influential Women in Business and Government Awards, and earlier in the year, the CEO Lifetime Country Achievement Award in recognition of her leadership excellence in the Southern African Development Community (SADC) region.

Prof Robert Millar received the Platinum Scientific Achievement Award of the South African Medical Research Council.

Prof Christof Heyns, Director of the Institute for International and Comparative Law in Africa (ICLA) and the UN Special Rapporteur on extrajudicial, summary or arbitrary executions, received the 2016 Don and Arvonne Fraser Human Rights Award by Advocates for Human Rights in Minnesota, USA, in recognition for his work in the United Nations.

Prof Ann Skelton, Director of the Centre for Child Law won the Juvenile Justice Without Borders International Award bestowed by the International Juvenile Justice Observatory, in recognition of her work in protecting the rights of children and improving the juvenile justice system in South Africa.

Prof Dave Berger of the Department of Plant Science was awarded, at the 2016 NSTF-South 32 award ceremony, the Special Annual Theme Award: Crop Science and Food Security in recognition of the 2016 International Year of Pulses declared by the United Nations.

Prof Celia Abolnik, who holds the Poultry Health and Production Research Chair in the Faculty of Veterinary Science, received a 2016 Regional Award of the African Union Kwame Nkrumah Scientific Awards Programme as one of Africa’s top five female scientists.

Dr Heinrich Badenhorst, senior lecturer and SARCHI Chair in Carbon Materials, received the Royal Society of South Africa’s Meiring Naudé Medal, in recognition of outstanding early career contributions.

Prof Lizette Jansen van Rensburg, Department of Human Genetics, received the Oettle Memorial Medal for 2016, CANSA’s highest honour awarded to South Africans who have made valuable contributions to cancer research and treatment.

Prof De Wet Swanepoel, Professor of Audiology at UP, received the S2A3 British Association Medal, one of the highest awards for original scientific research in southern Africa.

The South African Institute of Architects bestowed an Award of Excellence on the late **Prof Karel Bakker**, **Emeritus Prof Roger Fischer** and **Mr Nicholas Clarke** of the Department of Architecture for their publication *Eclectic ZA Wilhelmiens: A shared Dutch built heritage in South Africa*, which was the outflow of a UP research project co-funded by the Royal Netherlands Embassy in South Africa.

A number of UP academics were honoured at the annual awards of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns: former UP academic and Vice-Chancellor and Principal, and current Council member, **Dr Johan van Zyl**, received the Frans du Toit Medal for business leadership; **Emeritus Prof Ivan Horak** of the Faculty of Veterinary Science was awarded the MT Steyn Medal for Scientific and Technical Achievement; and **Prof Robert Pattinson** of the Faculty of Health Sciences received the Havenga Prize for Health Sciences.

A-RATED SCIENTISTS



NIGEL C BENNETT
Professor Bennett’s research investigates the ecological and physiological factors that affect the control of reproduction and the evolution of sociality. Molecular approaches, together with innovative laboratory and field methods, are used to unravel the mechanisms by which evolution can shape change in socially occurring vertebrate species. The family *Bathyerigidae* has turned out

to be an ideal model group for investigating the evolution of sociality and, as a consequence, contributes to the interdisciplinary efforts in the study of the causes and consequences of sociality.

Professor Bennett was made a Fellow of the African Academy of Sciences, and received the University of Pretoria Vice-Chancellor’s Award for Excellent Postgraduate Supervision in 2016.

Professor Nigel Bennett is in the Department of Zoology and Entomology and holds the UP Austin Roberts Chair of African Mammalogy and the SARCHI Chair of Mammalian Behavioural Ecology and Physiology.



DRUCILLA LC CORNELL
Professor Cornell’s work has looked at areas such as ethical humanism aimed at reviving black existentialism and radical constitutionalism to counter dominating historicism, imperialism and neo-colonialism. She has also researched female and racial subordination and liberalism post 9/11, particularly in the face of

wars in regions such as Afghanistan and Iraq. She founded the uBuntu Project in 2003 in the Western Cape, a project that promotes the status and importance of indigenous values and ideals across various areas of society. Her most recent work is on the contribution of African socialism to debates about economic justice.

Professor Drucilla Cornell is Extraordinary Professor in the Department of Jurisprudence at UP and Distinguished Professor in Political Science at Rutgers University, US.



DON A COWAN
Professor Cowan has a primary interest in the microbial ecology of soil habitats, including hot and cold desert soils. For the past decade and a half he has worked at both ends of the biological temperature scale, studying psychrophilic microbiology of the Dry Valleys of Eastern Antarctica, and the *thermophilic* microbiology of the Namib Desert. He collaborates with local, national and international researchers on many other metagenomic projects, ranging from studies of the roles of microbial communities on agricultural crop

productivity, in sub-Antarctic peat bogs, to the development of human prostate cancers. His newest research programme is the development of a large consortium of researchers to undertake a landscape-scale survey (for the first time) of the microbial diversity of sub-Saharan African soils.

With two other members of his research team, Pedro Lebre and Pieter De Maayer, Professor Cowan published a review in the prestigious international journal Nature Reviews Microbiology.

Professor Don Cowan is Director of the Centre for Microbial Ecology and Genomics, and of the Genomics Research Institute in the Faculty of Natural and Agricultural Sciences.



PEDRO CROUS
As a phytomycologist Professor Crous’s main interest lies in the evolution and phylogeny of plant pathogenic fungi, especially *Dothideomycetes*, *Diaporthales* and *Hypocreales*. Understanding and defining species means that the importance of sex (recombination) cannot be ignored. His research has shown that many plant pathogens have both mating type genes, and may be having cryptic sex, which also has serious implications for disease control and rates of evolution. He is interested in intra- and interspecies variation, and

how this relates to host specificity and speciation. Professor Crous actively pursues integrating DNA data with morphology and ecology. In this regard he initiated MycoBank to capture all fungal names, and now links taxa to their DNA data, cultures, specimens and ecology.

Professor Crous was awarded Honorary Membership of the Mycological Society of India in 2016. He was also included in the list of highest cited researchers (Plant and Animal Science) by Thomson Reuters.

Professor Pedro Crous is an Associate Professor in FABI, linked to the DST-NRF Centre of Excellence in Tree Health Biotechnology and the Tree Protection Co-operative Programme. He is Director of the CBS-KNAW Fungal Biodiversity Centre in Utrecht, The Netherlands.



ERIKA DE WET
Professor De Wet’s research examines the legal consequences that the exercising of public power by international organisations such as the United Nations and the African Union have for states and for those living in their territories. This includes the problems states face in implementing binding decisions of international organisations while giving due effect to other international obligations and constitutional principles of fundamental importance. She has held various national and international editorial positions and is a

member of the Scientific Advisory Board for Development Policy of the Max Planck Foundation for International Peace and the Rule of Law, as well as of the General Council of the International Society of Public Law (ICON-S), and is an Honorary Professor in the Faculty of Law of Bonn University.

Professor De Wet received the Käte Hamburger Center for Advanced Study in the Humanities ‘Law as Culture’ Fellowship (October 2015 through July 2016).

Professor Erika de Wet is Professor of International Law in the Faculty of Law and holds the DST-NRF SARCHI Chair of International Constitutional Law in the Faculty of Law.



ANDRIES P ENGELBRECHT

Professor Engelbrecht’s research interests include swarm intelligence, evolutionary computation, neural networks, artificial immune systems, and the application of these paradigms to data mining, games, bioinformatics, finance, and difficult optimisation problems. His research team has developed an open source library of computational intelligence algorithms, which is used internationally.

Professor Andries Engelbrecht is Head of the Department Computer Science in the Faculty of Engineering, Built Environment and Information Technology, and holds the DST-NRF SARCHI Chair in Artificial Intelligence.

They were the first to provide convergence proofs of particle swarm optimisers (PSO), and they have developed PSO and differential evolution algorithms to cluster non-stationary data. They have also developed new measures to characterise fitness landscapes of continuous-valued optimisation problems.



ROBERT P MILLAR

Professor Millar’s work has made major impacts in areas of human reproduction, hormone replacement and the treatment of disease such as cancer. His most recent research focuses on the breakthrough discovery that function can be restored to inactivating mutations in human G-protein-coupled receptors (GPCRs), which are responsible for most cell communication. This discovery unlocks the possibility for precision, personalised pharmaceuticals with the potential to treat a variety of diseases including blindness, obesity,

diabetes, and thyroid, muscle, kidney, reproductive and mental health conditions.

Professor Millar received the Platinum Scientific Achievement Award by the South African Medical Research Council (SAMRC) in 2016, and the John FW Herschel Medal in recognition of his highly distinguished multidisciplinary contributions to science. He was elected as President of the International Neuroendocrinology Federation (INF).

Professor Robert Millar is Director of the Centre for Neuroendocrinology in the Faculty of Health Sciences.



STELLA NKOMO

Professor Nkomo’s research focus is on race and gender and managing diversity in organisations and her scholarly contributions have helped to shape the discourse internationally. In addition to her scholarship, her greatest satisfaction comes from the supervision of postgraduate students and assisting young scholars in South Africa and Africa. She has held several national and international leadership positions. As founding President of the Africa Academy of Management (AFAM), she has focused on building a premiere continental association for management scholars in Africa and the diaspora who are committed to management knowledge building

for and about Africa. She serves or served on the editorial board of several international journals, and was recently appointed Senior Editor for the Diversity Management section of the Oxford Research Encyclopaedia of Business and Management.

In 2016 Professor Nkomo received the Continental Lifetime Achiever Award in the CEO Global Africa’s Most Influential Women in Business and Government Awards; and earlier in the year, received the CEO Lifetime Country Achievement Award in recognition of her leadership excellence in the Southern African Development Community (SADC) region.

Professor Stella Nkomo is Deputy Dean for Research and Postgraduate Studies in the Faculty of Economic and Management Sciences.



YVES VAN DE PEER

Professor Van de Peer was the first to suggest a correlation between whole genome duplication events in different plant lineages and the Cretaceous–Paleogene boundary, caused by the Cretaceous–Paleogene extinction event that wiped out about 70% of all organisms, including dinosaurs. Although whole genome duplications are usually an evolutionary dead end, research in Professor Van de Peer’s laboratory suggested that, during periods

of environmental upheaval, entire genome duplications can provide organisms with a selective advantage so that polyploids can out-compete their diploid progenitors. The research group of Yves van de Peer is widely recognised for their expertise in gene prediction and genome annotation and comparative and evolutionary genomics, and is involved in several international genome projects.

Professor Yves Van de Peer is part-time Professor at the Genomics Research Institute at UP, and Professor in Bioinformatics and Genome Biology in the Department of Plant Biotechnology and Bioinformatics, Ghent University, and the Department of Plant Systems Biology, VIB.



JOHAN VAN DER VYVER

Professor Van der Vyver is an expert in human rights jurisprudence and the international criminal court, and actively participated in efforts to end apartheid and bring constitutional reform to his native South Africa. He has also served as a fellow in the Human Rights

Program of The Carter Center in Atlanta. His research interests and publications include human rights, public international law, international criminal law, humanitarian law, and a great variety of other subject-matters.

Professor Johan van der Vyver is Extraordinary Professor in the Department of Private Law at UP.



CHARLES VAN ONSELEN

Professor van Onselen’s current interests lie in the phenomena of crime-as-politics and politics-as-crime. His most recently published work, *Showdown at the Red Lion: The Life and Times of Jack McLoughlin, 1859–1910*, is a case study of crime-as-politics set against the background of the emergence of social banditry in southern Africa at the turn of the 20th century. It offers a vivid example of the biographer’s craft by tracing the career of an Irish-Mancunian within the wider context of a South Africa’s industrial

revolution and exploring his life as an example working class consciousness and behaviour. *Showdown at the Red Lion* was shortlisted for the *Sunday Times* Alan Paton Award and Professor van Onselen was the recipient of the Vice Chancellor’s Book Award at the University. In 2016 he also presented, as part of the University’s Expert Lecture Series, a lecture titled: ‘Sunny Places for Shady Characters. The Making of Work Class Cultures in Southern Africa’s Mining Revolution, c.1886–1914’.

Professor Charles van Onselen is Research Professor in the Centre for the Advancement of Scholarship at the University of Pretoria.



JOHANNES VAN OORT

Professor Van Oort’s areas of research are the rise of Christianity in its Hebrew/Aramaic, Greek, Latin and Coptic contexts; the history of the Early Church, with particular attention to Gnostic-Christian movements; and the theology, sources and influences of the African church father Augustine of Hippo (354–430). In the past few years, the focus of his research was on Gnostic-Christian influences on

a number of Augustine’s theological and philosophical doctrines. Presently he is preparing a new commentary on the Confessions as well as new editions of Augustine’s anti-Manichaean writings in the UNESCO supported series *Corpus Fontium Manichaeorum* of which he is an editor-in-chief.

Professor Johannes van Oort is Extraordinary Professor in the Department of Church History in the Faculty of Theology at UP.



BRENDA WINGFIELD

Professor Brenda Wingfield’s research focus is on speciation and evolution of fungi, predominantly non model Ascomycetes. This includes research on genetic variation within as well as between species. Her research group enjoys substantial international recognition with respect to research on the molecular systematics and population genetics of fungal pathogens, and is considered as one of the leading teams worldwide that is involved in the development of molecular diagnostic techniques for the identification and classification of pathogenic fungi. Professor

Wingfield also has an interest in basic evolutionary biology based on ribosomal RNA-genes which extends beyond fungi, and has a variety of collaborations with research groups working on a range of organisms. Much of this collaboration is in association with the tree pathology research group and the DST-NRF Centre of Excellence in Tree Health Biotechnology in FABI.

In 2016 Professor Wingfield received the Harry Oppenheimer Fellowship Award to pursue her research field.

Professor Brenda Wingfield holds the SARCHI Chair in Fungal Genomics in the Department of Genetics. She is a member of the DST-NRF Centre for Excellence in Tree Health Biotechnology and the Tree Protection Cooperative Programme in FABI.



MICHAEL J WINGFIELD

Professor Mike Wingfield’s research focuses on fungal diseases that threaten forests and forestry globally. Using a broad range of approaches (especially molecular genetic techniques), pests and pathogens arising in many different countries of the world are identified – often for the first time. Research efforts seek to understand the drivers of tree pest invasions and to find methods to reduce the damage that they cause. His research programme falls under the umbrella of two major programmes: The Tree Protection Cooperative Programme, a cooperative venture between the University of Pretoria, all forestry companies in South Africa, the industry body Forestry South Africa (FSA), and the government

Department of Agriculture, Forestry and Fisheries (DAFF). The second major programme is the DST-NRF Centre of Excellence in Tree Health Biotechnology where the research focus is on the health of native trees and native woody ecosystems in South Africa. As IUFRO President, he actively promotes efforts to enhance evidence-based policy formulation on which the future of forests and the associated ecosystem services and global food security depend.

Professor Wingfield was awarded the Distinguished Leadership Award for International Scientists for 2016, by his alma mater, the University of Minnesota, and the Herschel Medal from the Royal Society of South Africa.

Professor Mike Wingfield is the founding Director of the Forestry and Agricultural Biotechnology Institute (FABI) at UP. He is also President of the International Union of Forest Research Organisations (IUFRO), one the largest and oldest scientific unions representing more than 15 000 forestry scientists globally.



XIAOHUA XIA

Professor Xia heads the South African National Hub for the Postgraduate Programme in Energy Efficiency and Demand-side Management, hosted by Centre of New Energy Systems (CNES) in the Faculty of Engineering, Built Environment and Information Technology (EBIT). His research interests are control systems and automation, and more recently, the modelling and optimisation of

energy systems. This includes non-linear feedback control, observer design, time-delay systems, hybrid systems, modelling and control of HIV/Aids, control and handling of heavy-haul trains and energy modelling and optimisation.

In 2016 Professor Xia was re-awarded his NRF A-rating, which he has held for a number of years.

Professor Xiaohua Xia is Director of the Centre of New Energy Systems (CNES) and holds the Exxaro Chair in Energy Efficiency.

NEW DEVELOPMENTS

Each year brings new developments and a realignment of the University of Pretoria’s research strategy and areas of research strength with renewed and urgent demands in ever-changing local and global contexts. In 2016, there were noteworthy research achievements, as are amply illustrated in this Review. Two areas of new developments are highlighted in this closing section: the new research entities established in 2016; and an intensified focus on research in and for Africa.

New research entities

In the Faculty of Health Sciences, two new research centres were established: The Centre for Viral Zoonoses; and the Research Centre for Maternal, Fetal, Newborn and Child Health Care. The UP Centre for Sustainable Malaria Control, also in the Health Sciences, became a research institute – the UP Institute for Sustainable Malaria Control (UP ISMC) – given its expanded scope of work, and collaborative regional and global partnerships.

Two further research institutes were established, each related to pressing contemporary issues, the first to lifestyle and wellbeing, and the second to a major economic focus in Africa: mineral resources and the resilience of the mining industry. The Institute for Sport, Exercise Medicine and Lifestyle Research was established in the

Faculty of Health Sciences; and the Mining Resilience Institute in the Faculty of Engineering, Built Environment and Information Technology.

Research in and for Africa

Central to the University of Pretoria’s vision and values is research that is a ‘public good’, and nowhere is this more visible than in our focus on Africa, and the ‘grand challenges’ that face developing regions and the world. It is in these contexts, in particular, that the critical needs for transdisciplinary, internationalisation and social responsibility are increasingly directing the development and impact of research and the role of universities globally (Slippers *et al.* 2014).

The Future Africa campus at the UP Experimental Farm is under construction, with a sod-turning event held in May 2016. The Future Africa programme is already firmly in place where Africa’s leading scientists and scholars from a broad range of disciplines come together to leverage the benefits of new approaches to team research, and a new transdisciplinary and convergence science paradigm, in tackling some of the complex issues facing both Africa and the global community.

In 2016, the focus was on the Africa Science Leadership Programme (ASLP) and the Tuks Young Research Leader Programme (TYRLP). The scope of Future Africa will be expanded, with well-developed plans in place to establish an institute focused on developing a new generation of transformation-minded science leaders in Africa, and actively to build networks between science leaders across Africa and the rest of the world.



Editorial team

Professors Don Cowan, Robin Crewe, Jenny Hoobler, Michael Pepper and Bernard Slippers

Project manager, writer and editor

Hanlie Griesel

Photography

Eyescape, web images, and as per individual credits

Design, layout, and publishing

Words’worth

Printing

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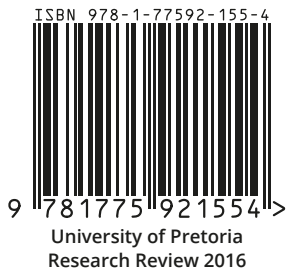
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Please visit <http://www.up.ac.za/research-innovation> for the electronic searchable copy of the Review, and the research outputs of 2016, linked to UPSpace, the online open-source repository of the University of Pretoria.

Dr Nthabiseng Taole

Director: Department of Research and Innovation





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