

DEPARTMENT OF
BOTANY AND ZOOLOGY

RESEARCH INTERESTS

Biotic diversity and ecology of the Cape Region and its coastline; Systematics and molecular ecology; Evolutionary ecology; Marine biology; Medicinal plant biology; Global change biology; Invasion biology

RESEARCH HIGHLIGHTS

Functional diversity and trait filtering of insectivorous bats relate to forest biogeography and fragmentation in South Africa

Forest fragmentation is a major driver of biodiversity loss causing declines in species richness and functional diversity of biotic communities. Bats are essential components of ecosystems and are useful bio-indicators of habitat disturbance, yet the response of bats to fragmentation has been poorly studied in Africa.

Monika Moir, a PhD student supervised by **Dr Victor Rambau** and **Prof Michael Cherry** at SU's Department of Botany and Zoology, in collaboration with Dr Leigh Richards from the Durban Natural Science Museum, assessed the effects of forest biogeographical history and fragmentation on functional diversity of bats and their functional traits in South Africa.

They found Pondoland Scarp forests displayed high functional richness, while Eastern Cape Dune forests exhibited high functional divergence yet low functional richness. Also, two forest fragmentation metrics had significant effects on functional diversity: edge density had a positive effect on functional evenness; dispersion was negatively affected by the length of rivers transecting through forests. They attributed the high species and functional richness found in Scarp forests to events of their biogeographical history as they experienced less extreme climatic extinction filtering than Mistbelt forests during the Last Glacial Maximum, whereas the low diversity of Eastern Cape Dune forests results from their younger evolutionary history and homogenous vegetation structure.

Lastly, they showed forest patch size exhibited the strongest associations with species traits in that larger-sized insectivorous species and species exhibiting low wing loading may be more vulnerable to fragmentation. This work was published in the *Journal of Biogeography* – **Dr Monika Moir**



Dr Monika Moir holding a Wahlberg's epauletted fruit bat (*Epomophorus wahlbergi*) while catching bats in Mbotyi State Forest in the Eastern Cape. PHOTO: EMMANUEL MATAMBA

Quantum dots and pollen wars

Quantum dots are fluorescent nano crystals which will glow in different colours when a UV light is shone on them. The Bio-interactions Lab, led by **Prof Bruce Anderson**, has pioneered their use in ecology and evolutionary studies. In particular, they have found that quantum dots can be used to label and distinguish pollen grains from different individuals, enabling them to answer questions about how pollen grains potentially compete with one another for limited space on the bodies of pollinators.

Dr Monika Moir, a post-doctoral fellow, found that the pollen grains found on pollinators are not randomly distributed but are placed in layers so that the top layers are from the most recently visited

flowers while the bottom layers are from the first flowers visited.

Furthermore, when a thick layer of pollen coats the body of a pollinator, it can prevent new pollen from attaching to pollinators. This means that visits to flowers will not necessarily result in effective pollen transfer from the flower to the pollinator. This brings up the interesting possibility that some plants may have evolved structures to clean pollen from pollinators before depositing their own. This exciting work is being continued by Prof Anderson. Dr Monika Moir is now studying COVID evolution at the Centre for Epidemiological Response and Innovation at Stellenbosch University.

– **Prof Bruce Anderson**



A fly visits a *Moraea lurida* flower and in doing so, it receives a thick layer of pollen on its thorax (left). The picture on the right shows pollen labelled with yellow quantum dots lying on top of pre-existing orange pollen. We found that the more pre-existing pollen on the fly, the fewer labelled pollen grains were placed onto the visiting flies. PHOTO: BRUCE ANDERSON

Rivers serve as wildlife corridors for forest-dependent insectivorous birds in a fragmented landscape

In South Africa, where native forests are naturally fragmented, forest-dependent birds have undergone range declines since 1992, most notably among insectivores. These insectivores appear sensitive to the quality of natural matrix habitats, and it is unknown whether transformation of the landscape matrix has disrupted gene flow.

Postgraduate student Jake Mulvaney undertook a landscape genetics study of four forest-dependent

insectivorous songbirds across the Eastern Cape and southern KwaZulu-Natal, and detected pronounced declines in breeding population sizes over the past two centuries for the endemic forest specialist Chorister robin-chat and Cape Batis, alongside recent gene flow disruption in both these species and the Starred robin. The yellow-throated woodland warbler appears least reliant upon landscape features to maintain gene flow, and was least impacted by anthropogenic landscape transformation. Collectively, gene flow in all four species is improved at lower elevations, along river valleys, and riparian corridors — where native forest and dense thicket



Postgraduate student Jake Mulvaney with a Choister robin-chat from which he has just taken a blood sample for genetic analysis. PHOTO: MIKE CHERRY

better persist. This demonstrates the benefits of wildlife corridors for South African forest-dependent bird conservation, to ameliorate the extinction debts from past and present anthropogenic forest exploitation. – **Prof Mike Cherry**

Searching for fish in the mangroves

After a break from all field work in 2020, we were finally able to return to the field in 2021. MSc student Jamila Janna collected all her samples for metabarcoding analyses, first combing South Africa's mangroves on the east coast then heading up to Inhambane Bay, Mozambique. Her project, supervised by **Dr Nasreen Peer** and **Prof Sophie von der Heyden**, aims to look at whether or not fish diversity in mangroves, an important nursery habitat, is influenced by human activity using metabarcoding as well as baited remote underwater video (BRUV) systems. A highlight for Jamila was getting to meet the Inhambane Bay community collaborators who are closely involved and always looking for new ways to manage their bay. Her results will be useful to them as well in their continuous monitoring efforts. In another highlight of the year, Jamila participated in the SU FameLab heat and placed third, capping off an already successful year. – **Dr Nasreen Peer**



Jamila Janna collecting eDNA samples from the Beachwood mangroves in Durban. PHOTO: TSEPO MLAMBO



Senhor Luciano Nhamussua, a community collaborator, assists postgraduate student Jamilla Janna with sampling. The Inhambane community is already familiar with the technique as they have been trained to collect eDNA samples for the last few years. PHOTO: JAMILA JANA

Dolphins love a good natter over breakfast

Animals transmit important information by making sounds and studying animal communication may provide clues about how they are feeling. A team from Stellenbosch University, Sea Search and the University of KwaZulu-Natal have been investigating what important information might be hidden within dolphin whistles.

Dr Tess Gridley and **Dr Simon Elwen**, both associated with SU's Department of Botany and Zoology, and PhD-student Rachel Probert from the University of KwaZulu-Natal, focused on ten dolphins housed at uShaka Sea World, Durban. They discovered that the dolphins were almost entirely silent overnight. However, in the morning when trainers arrived and particularly at feeding time, some dolphins became incredibly chatty. Dolphin calls are difficult to hear in-air, therefore they used underwater microphones, called hydrophones, to listen to the dolphins communicate. They found that certain individuals became particularly excited while waiting for food or being fed and the dolphins would whistle their signature whistle over and over again, which is similar to calling out their own name. The

study provides important insight into the emotions of dolphins and how underlying behavioural states, such as excitement or calmness, can be determined using acoustic monitoring. Now that they have a baseline understanding of each dolphin's whistling behaviour, any changes in this could potentially be linked to a change in the wellbeing of the animal.

– **Drs Tess Gridley and Simon Elwen**



One of the dolphins housed at uShaka Sea World, Durban, was one of ten dolphins monitored. PHOTO: SOUTH AFRICAN ASSOCIATION FOR MARINE BIOLOGICAL RESEARCH



RESEARCH ACTIVITIES

Prof Bruce Anderson gave his inaugural lecture, titled "The Incredible Journey of Pollen" in hybrid format. He is an associate editor of the journals *Proceedings of the Royal Society B* and *Journal of Pollination Ecology*.

Prof Mike Cherry serves on the steering committee of the DSI-NRF Centre of Excellence in Birds as Keys to Biodiversity Conservation at the Percy FitzPatrick Institute for Ornithology. He is an associate editor of *Emu*. During 2021 he also published ten articles in the not-for-profit news agency *GroundUp* on COVID-related matters.

Prof Susana Clusella-Trullas is subject editor of *Ecography* and on the editorial advisory board of the *Journal of Experimental Biology*. She is a member of the IUCN Species Survival Commission's Ladybird Species Group. During 2021 she presented at two international conferences: "Exploring behavioural thermoregulation as a key moderator of climate change impacts" at the 23rd International Congress of Zoology, South Africa, from 22 to 24 November 2021; and "Mechanisms of infrasound detection in birds: a phylogenetic comparative test of middle and inner ear anatomical structures" in *Human Frontier Science Program*, from 5 to 8 July 2021.

Prof Savel Daniels is an editor of the *Journal of Zoological Systematics and Evolutionary Research* and frequently participates in the RSG radio program "Hoe verklaar jy dit?"

Prof Léanne Dreyer serves on the editorial board of *Botany Letters* and frequently gives interviews on RSG radio.

Prof Allan Ellis presented a popular research talk titled "Fly pollination of mass flowering daisies in the Succulent Karoo" to the Gobabeb Namib Desert Research Station, Namibia, in January 2021.

Prof Nox Makunga is on the editorial board of *Plants*.

Prof Conrad Matthee is an associate editor to *Molecular Phylogenetics and Evolution* and on the

editorial board of the *African Journal of Marine Science* and *Koedoe*. He also convenes the NRF Zoology rating panel, focusing on aquatic sciences.

Prof Guy Midgley is involved with several national and international policy relevant projects in the field of biodiversity and climate change, including lead author for the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), completed in 2021.

Dr Marnel Mouton is an associate member of the Legitimate Code Theory Centre, University of Sydney, Australia, and together with colleagues from Stellenbosch University, worked on a book, *Enhancing Science Education: Exploring knowledge practices with Legitimation Code Theory*, which will be published in 2022 as part of Routledge's series on the use of Legitimation Code Theory to enhance teaching and learning in higher education.

Dr Nasreen Peer attended the International Congress of Conservation Biology as an invited panelist. She presented a guest lecture at the University of Waterloo to Political Ecology undergraduates. She was appointed to a Department of Forestry, Fisheries and the Environment (DFFE) independent panel put together by Minister Barbara Creecy to investigate the impacts of artificially breaching the St Lucia estuary, a world heritage site. She will chair the panel until the end of March 2022.

Dr Victor Rambau is an associate editor of *African Zoology* and a board member of the Mammal Research Institute, University of Pretoria. He is also active on a number of NRF funding panels.

Prof Tammy Robinson-Smythe presented a paper, "Predator-driven biotic resistance: insights from native rock lobsters and alien mussel prey along the South African coast", at the First International Symposium on Coastal Ecosystems and Global Change, Xiamen, China, in April 2021. She is thematic editor of the *World Register of Introduced Marine Species (WRiMS)* and associate editor of *Aquatic Invasions and BioInvasion Records*.

Prof Dave Richardson is a member of the IUCN Species Survival Specialist Group on Invasive Organisms. He serves as an associate editor of *Biological Invasions and Neobiota* and as editorial advisory board member of *Forest Ecosystems*, *AoB PLANTS* and *Frontiers of Biogeography*.

Prof Carol Simon is chair of the local organizing committee of the 14th Polychaete Conference to be held in Stellenbosch in 2023. She presented a paper titled "Why taxonomy is increasingly important in the Anthropocene: A South African polychaete perspective" at the 23rd International Congress of Zoology, South Africa, from 22 to 24 November, including a webinar associated with organising the International Polychaete Conference, titled "Bristling with Biodiversity: Unravelling polychaete knowledge one 'Day' at a time" in July 2021.

Prof Sophie von der Heyden is chair of the steering committee of the South African Network for Coastal and Oceanographic Research (SANCOR) and a member of the Ocean Best Practices, Intergovernmental Oceanographic Commission, UNESCO. She is the secretary of the Conservation Genetics working group and on the Equity, Inclusion and Diversity (EID) committee of the Society for Conservation Biology.

Prof Theresa Wossler is co-editor-in chief of *African Zoology* and serves on the City of Cape Town Protected Areas Advisory Committee for the Helderberg Nature Reserve.

ACADEMIC AFFAIRS

Postgraduate student cohort 2021

The School for Climate Studies, launched in July 2021, aims to create a transdisciplinary vehicle to leverage the climate-related knowledge and capacity of relevant faculties, informing and informed by the public and private sectors' climate policies, initiatives and needs. This inter-faculty entity is hosted in the Department of Botany

and Zoology, under the Directorship of Prof Guy Midgley, and is currently developing research, policy and teaching capacity in a number of thematic areas. Social impact outcomes aligned with SU's mission are being addressed in both academic and applied ways, supporting a just transition to a climate resilient and low carbon society in South Africa.

Postgraduate student cohort



AWARDS TO STAFF AND STUDENTS

Prof Guy Midgley was ranked 180th (out of 1000) in the world of the most influential climate academics according to Reuters. **Prof Dave Richardson** was listed as a Highly Cited Researcher 2021, according to the Web of Science. He was also recognised by Stellenbosch University for his research contributions in 2018. **Prof Bruce Anderson** received a B2-rating from the National Research Foundation.

Kayla Liebenberg, a BScHons student with Prof Dave Richardson, was awarded the prize for the best student presentation at the Fynbos Forum, 2021. **Kaylan Reddy**, a PhD student with Prof Nox Makunga, received two awards at international conferences. One for the best poster in Ethnobotany at Botany 2021 Virtual, hosted by the Botanical Society of America; and the other for the best PhD presentation at the International Symposium of Phytochemicals in Medicine and Food 2021, hosted by the Phytochemical Society of Europe and the Phytochemical Society of Asia.

In 2021, the Zoological Society of South Africa recognised **Grace Warner** and **Jessica Stephens** as the best BScHonours and third year students in zoology at Stellenbosch University for 2020.

The Marine Genomics and Conservation Lab under the leadership of **Prof Sophie von der Heyden** won the Inqaba Biotech Genome Sequencing challenge to have *Zostera capensis* genome sequenced at no cost.



PhD-student Kaylan Reddy. PHOTO CREDIT: STEFAN ELS

“ PhD-student Kaylan Reddy won the best poster and the best PhD presentation awards at two international conferences.

STAFF MATTERS

Prof Alex Valentine, a plant physiologist within the Department, resigned to take up a position at Yara in the United Kingdom as a Research and

Development Scientist. **Mr Benjamin Peterson** resigned due to personal reasons.

SOCIAL IMPACT

limbovane Outreach Project

limbovane is a science education programme that provides curricular support to learners and educators in the field of biodiversity and environmental science while it raises awareness of science as an interesting and attractive career among learners.

The most important highlight of 2021 was the limbovane team's return to the classroom in person. After a year without any practical work in 2020, both the limbovane team and learners were thrilled to get outside for field investigations. Despite direct school-based engagements remaining constrained due to COVID-19 restrictions, shortened school terms and rotational teaching schedules, the limbovane team still managed to conduct 41 school-based lessons at partner schools. These lessons included biodiversity theory as well as fieldwork that enabled participating learners to develop basic practical scientific skills. During these school visits limbovane trained 841 high school learners.

Mr Ivan Dwashu, a Life Science educator at Diazville High School in Saldanha, highlighted the value of the practical component of limbovane and how educators and learners benefit from it:

"The limbovane Project is beneficial to Grade 10 learners as it ties in with the topic of biodiversity. It essentially shows biodiversity in action. Learners can be assessed on this topic by inserting it as a case study in an assignment or test or exam paper. It is also helpful in explaining the topic of classification as learners learn valuable skills such as using scientific keys to identify ants, which can also be assessed in an assignment, test or exam."

limbovane also collaborated with the Iziko South African Museum in hosting a series of educator workshops, titled *An Afternoon with Ants*. These workshops took place at the Museum's new Biodiversity Laboratory, giving the attendees the opportunity to use the laboratory's high-quality microscopes. The workshops were attended by curriculum planners and educators from the Western Cape Education Department (WCED)

and environmental educators from Contour Enviro Group, the Wildlife and Environment Society of South Africa (WESSA), Iziko South African Museum and Cape Nature. Feedback indicated that these workshops were successful in increasing educators' enthusiasm and capacity in teaching the topic of biological classification at the Grade 7 and Grade 10 level.

According to Ms Suanne Rampou, deputy chief education specialist for natural sciences in the WCED, classification is a challenging concept in the Grade 7 curriculum: "The workshop demystified the concept and process of classification by using ant species. It can be useful to educators and learners and can be used for practical assignments and as part of formal assessments."

limbovane had the privilege of hosting five learner workshops in collaboration with partners from its education network, including Nature Connect, SANBI, SANParks, Contour Enviro Group and the Cape Leopard Trust. A total of 118 learners were trained during these workshops.

Another highlight of 2021 is limbovane's collaboration on a project funded by the Foundational Biodiversity Information Programme (FBIP) to review an important ant group. limbovane's role in the project is the contribution of ant specimens from the *Anoplolepis* genus that were collected by learners who participated in limbovane between 2006 and 2014. These specimens were barcoded, and the resulting molecular data will help to confirm species identification and update identification keys to the genus. limbovane also provided researchers on the project with a platform to share their expertise with the public. MSc student Abusisiwe Ndaba, a taxonomist at the Iziko South African Museum, assisted the limbovane team in presenting classroom lessons during the team's school visits and workshops. She said limbovane gave her the perfect platform to engage with the learners and teach them about taxonomy and the diversity of ants around them.



A Grade 10 learner from Luhlaza Secondary School in Khayelitsha learning basic scientific tools – using a microscope and a dichotomous key. PHOTO: DORETTE DU PLESSIS

The project is very grateful to schools and educators who made it possible for us to continue with our school-based activities despite the restrictions. A big thank you to Rand Merchant Bank, Mapula Trust, BRO Trust and the Het Jan Marais Fonds for financial support. – Ms Dorette du Plessis

“ The limbovane Project is beneficial to Grade 10 learners as it ties in with the topic of biodiversity. It essentially shows biodiversity in action.



Learners learning valuable practical scientific skills, such as following a scientific protocol, measuring and observing, while conducting biodiversity surveys in their school grounds. PHOTO: DORETTE DU PLESSIS

COLLABORATION

Australia

- Macquarie University
- Royal Melbourne Institute of Technology (RMIT) University
- Belgium
- Royal Museum Central Africa
- Ghent University

Canada

- University of British Columbia
- University of Toronto

China

- Academy of Science and Technology
- Huazhong Agricultural University
- Zhejiang Chinese Medical University

France

- Foundation for Biodiversity Research
- Museum national d'histoire naturelle
- University of Montpellier

Germany

- Technical University of Dresden
- University of Frankfurt

Mozambique

- Eduardo Mondlane University
- Ocean Revolution and Community Council of Fishers

South Africa

- Cape Peninsula University of Technology
- Council for Scientific and Industrial Research (CSIR)
- Department of Environment, Forestry and Fisheries
- Durban Natural Science Museum
- Nelson Mandela University
- Rhodes University
- South African National Biodiversity Institute (SANBI)
- South African Institute of Aquatic Biodiversity
- University of Cape Town
- University of the Free State
- University of Johannesburg

- University of KwaZulu-Natal
- University of Pretoria
- University of the Western Cape
- Wild Bird Trust

Switzerland

- University of Fribourg
- University of Lausanne

United Kingdom/Ireland

- Cambridge University
- Kew Botanical Gardens
- Oxford University
- University of Leeds

United States of America

- Harvard University
- Hofstra University
- Northern Michigan
- Trinity College
- University of Arizona
- University of California
- Washington University

Other

- Charles University, Prague, Czech Republic
- National University of Singapore, Singapore
- Severtsov Institute of Ecology and Evolution, Russia.
- University of Leiden, Netherlands
- Universidad Pablo de Olavida, Spain
- University of Vienna, Austria
- Wageningen University, Netherlands

FUNDING

Belgium

- Directorate-general Development Cooperation
- Belgium, Flanders – South Africa National Research Foundation (NRF) International
- Centre for Agriculture and Bioscience International (CABI)

Germany

- Centre for Energy Technology
- Thünen Institute of Climate-Smart Agriculture

South Africa

- Council for Scientific and Industrial Research (CSIR)
- Department of Science and Innovation
- Escom Annual Koeberg Monitoring
- Forestry and Agricultural Biotechnology Institute (FABI)
- Foundational Biodiversity Information Programme (FBIP)

- Human Frontier Science Programme
- Het Jan Marais National Fund
- Marine and Coastal Research
- National Research Foundation Competitive Programme for Rated Researchers
- Newton Mobility Grant
- Oppenheimer Memorial Trust
- Royal Museum of Central Africa
- SA Berry Producers
- South African National Biodiversity Institute
- Stellenbosch University
- SA-Mozambique-Zambia Trilateral Joint Science and Technology collaboration
- Western Indian Ocean Marine Science Association
- Wild Bird Trust

United Kingdom

- Royal Society
- University of East Anglia

NRF-RATED RESEARCHERS

LEADING INTERNATIONAL RESEARCHERS

Prof GF Midgley Ecology and ecophysiology

Prof DM Richardson Biological invasions and conservation biogeography

INTERNATIONALLY ACCLAIMED RESEARCHERS

Prof BA Anderson Plant-animal interactions

Prof S Daniels Molecular systematics, phylogeography and conservation of invertebrates

Prof AG Ellis Evolutionary ecology of plants and insects

Prof CA Matthee Molecular systematics and phylogeography

Prof CA Pauw Evolutionary ecology of plants and their pollinators

Emeritus Prof D Baird Marine ecology

Emeritus Prof B van Wilgen Biological invasions and conservation

Extraordinary Prof J Wilson Biological invasions and conservation

Extraordinary Prof WJ Przybylowicz Applications of nuclear microprobes in biology

ESTABLISHED RESEARCHERS

Prof S Clusella-Trullas	Thermal adaptation of ectotherms and implications for climate
Prof LL Dreyer	Evolution of Cape Flora
Prof NP Makunga	Medicinal plant bio-technology
Prof TB Robinson	Drivers, patterns and impacts of marine invasions
Prof CA Simon	Marine invertebrates; reproduction and polychaete worm taxonomy
Prof S von der Heyden	Marine molecular ecology and conservation
Dr S Kumschick (CIB)	Invasion biology
Prof J Measey (CIB)	Conservation and ecology of invasive species
Extraordinary Prof L Foxcroft	Invasion ecophysiology
Extraordinary Prof JM Mesjasz-Przybylowicz	Plant ecophysiology

STAFF LIST

Academic

- Prof BA Anderson
- Prof MI Cherry
- Prof S Clusella-Trullas
- Prof SR Daniels
- Prof LL Dreyer
- Prof AG Ellis
- Dr AF Flemming
- Prof NP Makunga
- Prof CA Matthee
- Prof GF Midgley
- Dr M Mouton
- Prof CA Pauw
- Dr N Peer
- Dr VR Rambau
- Prof DM Richardson
- Prof TB Robinson-Smythe
- Ms Z Shaik
- Prof CA Simon
- Prof S Von der Heyden
- Prof TC Wossler (Head of Department)

Academic Staff: Centre of Excellence for Invasion

Biology

- Dr S Kumchick
- Prof J Measey
- Prof J Wilson (Extraordinary professor)
- Prof B van Wilgen (Emeritus professor)

Extraordinary Appointments

- Dr S Elwen
- Prof W Foden
- Prof L Foxcroft
- Dr T Gridley
- Prof J Le Roux
- Prof W Przybylowicz
- Prof J Przybylowicz
- Prof JR Wilson

Emeritus professors

- Prof D Baird
- Prof J Gilomee
- Prof JAJ Nel
- Prof AJ Reinecke
- Prof SA Reinecke
- Prof TJ Robinson

- Prof VR Smith
- Prof DE van Dijk
- Prof B van Wilgen
- Prof H Van Wyk

Support staff

- Ms J Basson
- Ms F Gordon
- Ms S Jacobs
- Ms S Johnson-Abrahams
- Ms DJD Julies
- Ms J Hutton
- Ms MJ Mathese
- Ms AC Nel
- Mr R Robertson
- Ms MP Sauerma
- Mr N Solomons
- Mr JP Williams
- Mr H Witbooi

Support staff: Centre of Excellence for Invasion Biology

- Ms D du Plessis
- Ms S Kritzinger-Klopper

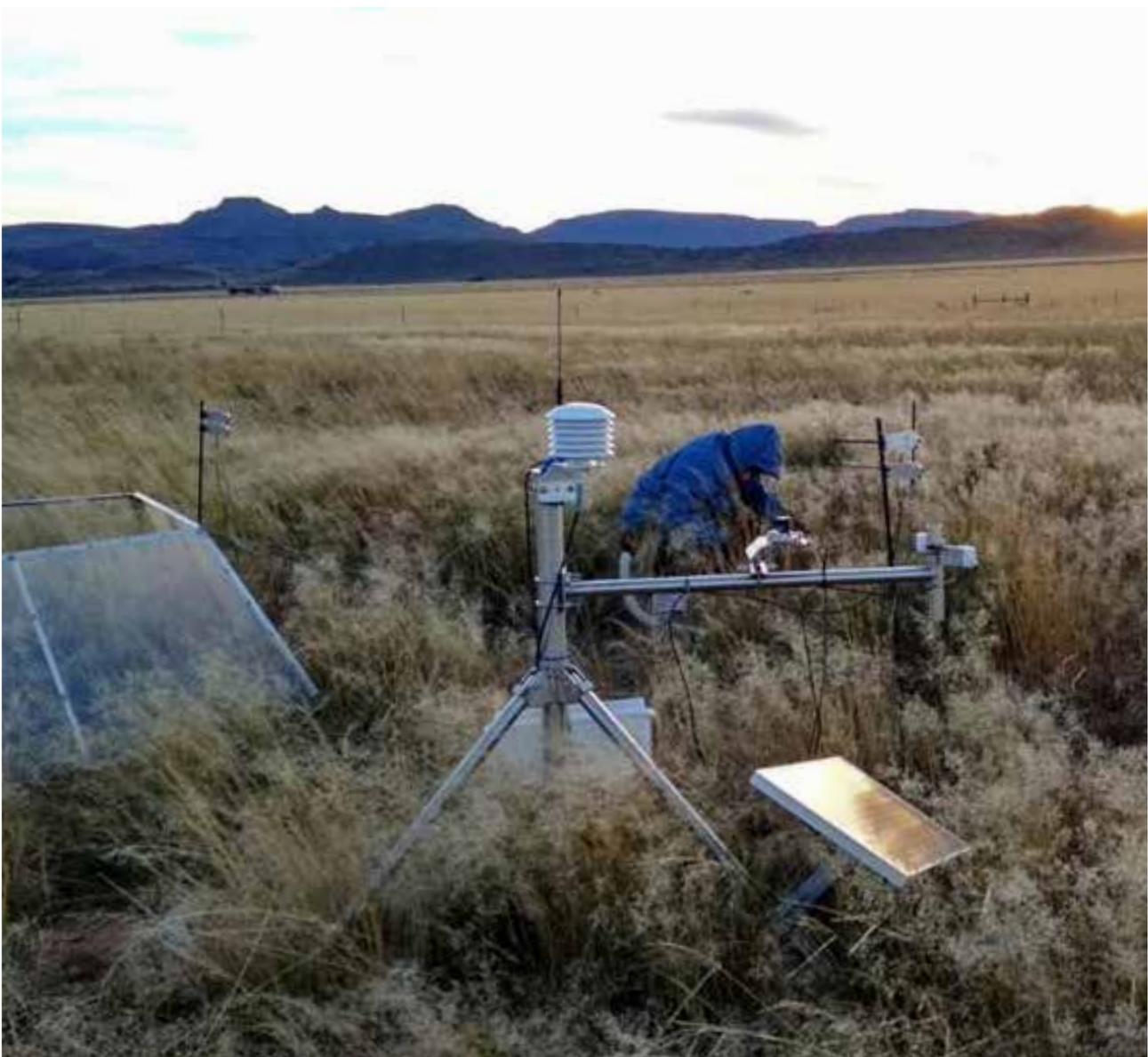
- Ms C Momberg
- Ms L Msomi
- Ms E Nortjé

Postdoctoral fellows

- Dr A Alvarez Aguilar
- Dr S Andreotti
- Dr J Baxter-Gilbert

- Dr H Beckett
- Dr C Botella
- Dr A Da camara dandas
Ferreira
- Dr H Hirsch
- Dr JH Keet
- Dr B Loedolf
- Dr NA Masondo

- Dr A Melotto
- Dr M Moir
- Dr A Ndhlovu
- DR MM Nsikani
- Dr N Stevens
- Dr JL Van Velden



CONTACT DETAILS

Tel: +27 21 808 3236 | Fax: +27 21 808 2405

botzoo@sun.ac.za | www.sun.ac.za/botzoo