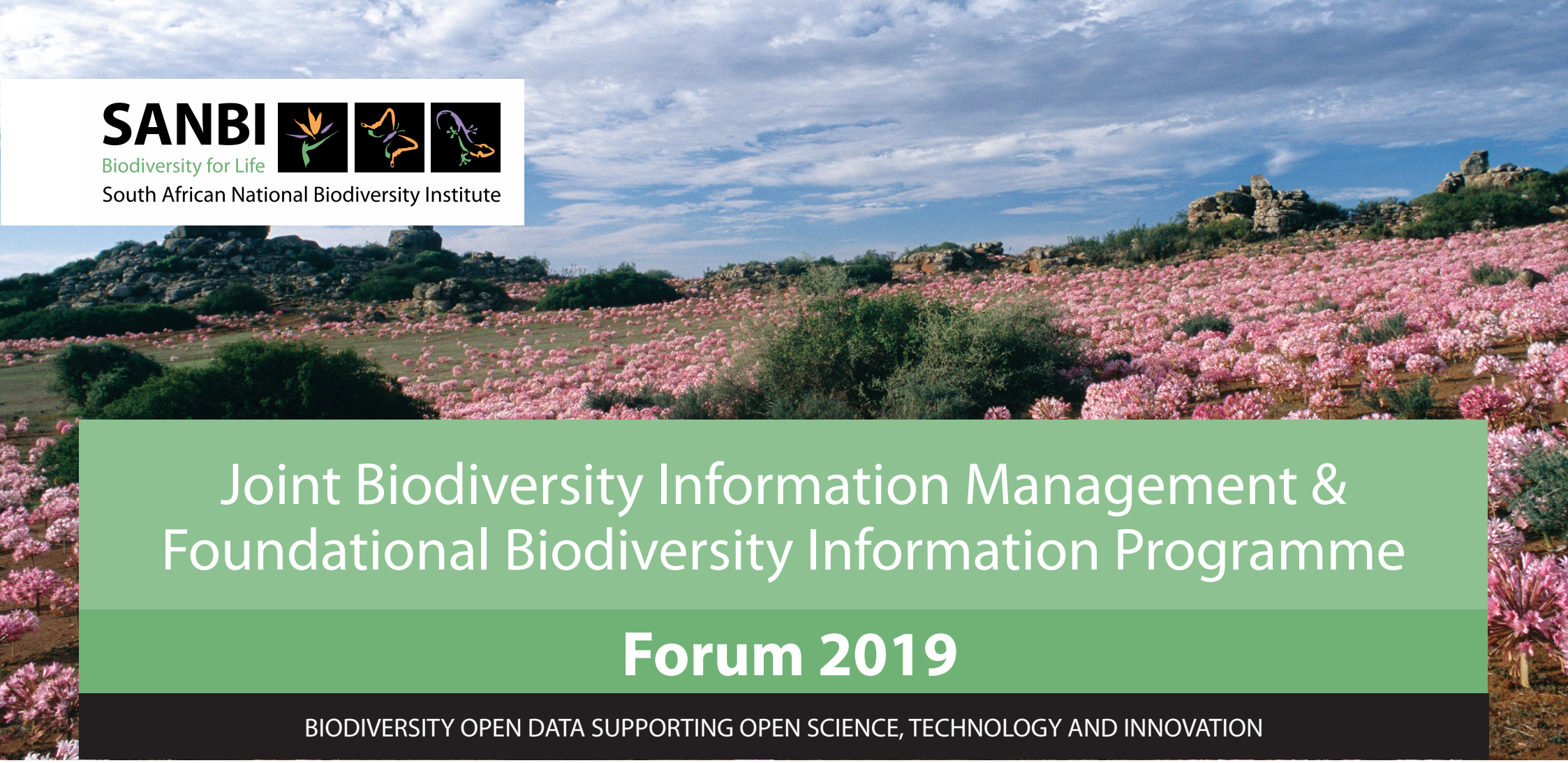

SANBI
Biodiversity for Life
South African National Biodiversity Institute

# Joint Biodiversity Information Management & Foundational Biodiversity Information Programme

# Forum 2019

## BIODIVERSITY OPEN DATA SUPPORTING OPEN SCIENCE, TECHNOLOGY AND INNOVATION

20–22 August 2019
Roodevalley Faircity Hotel, Pretoria

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation

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# PROGRAMME

| MONDAY, 19 AUGUST 2019<br>ROODEVALLEY FAIRCITY HOTEL, PRETORIA | |
|---|---|
| **FBIP POSTGRADUATE STUDENT FORUM** | |
| **Facilitator:** | **Leigh Richards** |
| 12:00–13:00 | Student delegate arrival and registration. |
| 13:00–14:00 | Lunch |
| | |
| 14:00–14:15 | Opening and welcome by Prof Sebola from SANBI |
| 14:15–15:00 | Scientific career role modelling (invited guest speakers - Prof Annah Moteetee, Dr Caswell Munyani and Dr Tshifhiwa Mandiwana-Neudani) |
| 15:00–15:30 | Interactive panel discussion |
| 15:30–16:00 | Tea |
| | |
| 16:00–17:30 | Permitting requirements by Ms Karin Behr |
| 17:30 | Student meeting and Icebreaker |

## TUESDAY, 20 AUGUST 2019
## ROODEVALLEY FAIRCITY HOTEL, PRETORIA
### DAY ONE

Objectives:

1. Understanding the Science, Technology and Innovation White Paper; exploring the opportunities and existing contributions of biodiversity data from participating institutions.
2. Profiling institutional contributions to Open Data and Open Science.
3. Tracking the FBIP's progress in delivering foundational biodiversity information to address priority needs.
4. Exploring regional collaboration to mobilise biodiversity data.
5. Supporting Science, Technology and Innovation.

| Time | Session Title | Presenter |
|---|---|---|
| 08:00–09:00 | Registration | |
| 09:00–09:15 | Official welcome and introduction. | SANBI Executive |
| 09:15–09:30 | Opening address by the Department of Science and Innovation. | Leluma Matooane (DSI) |
| 09:30–09:45 | National Research Foundation: Global Change Programme. | Andrew Kaniki / Jonathan Diederiks (NRF) |
| 09:45–10:15 | **Keynote address 1**<br>The 2019 Science, Technology and Innovation White Paper. | Urszula Rust (DSI) |
| 10:15–11:00 | Tea and group photo | |
| 11:00–11:30 | **Keynote address 2**<br>The IPBES Global Assessment is overwhelming! Can we have too much Information and not enough data to spark action? | Kiruben Naicker |
| 11:30–12:45 | **Plenary: Open data for open science.** | |
| | **Talk 1:** The Global Biodiversity Information Facility: A mega-science initiative coordinating biodiversity informatics through an open resource infrastructure. | Fatima Parker-Allie |
| | **Talk 2**: Biodiversity Heritage Library (BHL): A source of big data and analysis. | Lawrence Monda & Anne-Lise Fourie |
| | **Talk 3:** Open data for the public good. | Peter Lukey |
| | **Talk 4:** Building a database of Lepidoptera–host–parasitoid associations recorded for the Afrotropical region. | Hermann Staude |
| | **Talk 5:** Is South Africa ready for metabarcoding? | Sandi Willows-Munro |
| 12:45–13:30 | Lunch | |

| | | | |
|---|---|---|---|
| 13:30–15:30 | **Plenary: Foundational Biodiversity Information Programme (FBIP) – linking funding priorities with national projects and initiatives.** | | |
| | **Talk 1:** | FBIP: an overview of the programme funding approach, update of grants awarded and capacity development strategies. | Lita Pauw |
| | **Talk 2:** | An update on Foundational Biodiversity Information Programme (FBIP) generated data. | Mahlatse Kgatla |
| | **Talk 3:** | Informal forest product harvesting and avian diversity in the Eastern Cape. | Michael Cherry |
| | **Talk 4:** | BioGaps: filling biodiversity information gaps to support development decision making in the Karoo. | Domitilla Raimondo |
| | **Talk 5:** | Snapshot Safari: progress to date and future directions. | Lain Pardo Vargas |
| | **Talk 6:** | Soil *Fusarium* survey in the Great Karoo biome of South Africa. | Riana Jacobs |
| | **Talk 7:** | Developing an operational framework for unlocking coastal plankton biodiversity information: progress, challenges and the ambitious march towards an informed future. | Shaun Deyzel |
| 15:30–16:00 | Tea/coffee | | |
| 16:00–17:00 | **Plenary: Regional Biodiversity Information Efforts – opportunities and challenges.** | | |
| | **Talk 1:** | Strengthening biodiversity informatics and data mobilisation efforts nationally and regionally through SANBI-GBIF and the African Coordinating Mechanism. | Fatima Parker-Allie |
| | **Talk 2:** | The African Open Science Platform (AOSP): fostering a culture of open data within African National Systems of Innovation. | Susan Veldsman |
| | **Talk 3:** | Lessons learned from stimulating biodiversity informatics networks through the African Biodiversity Challenge. | Matthew Child |
| | **Talk 4:** | Enhancing the accessibility of biodiversity data in Malawi through partnerships and biodiversity information management tools (**speed presentation**). | Donald Mpalika |
| | **Talk 5:** | Enhancing biodiversity data mobilisation, management and utilisation in off reserve areas in Ghana: using CREMAs as a model (**speed presentation**). | Raymond Owusu-Achiaw |
| 17:00–17:45 | **Plenary:** Exploring the Science, Technology and Innovation White Paper 2019. | | Facilitated session |
| 17:45–18:45 | **Posters, demonstrations and networking session** | | |

## WEDNESDAY, 21 AUGUST 2019
## ROODEVALLEY FAIRCITY HOTEL, PRETORIA
### DAY TWO

Objectives:
1. Profiling research infrastructures and platforms that support data management and dissemination.
2. Building our national communities of practice, networks and structures for biodiversity data management.
3. Developing our human capital for biodiversity data science- and management.

| Time | Session Title | Presenter |
|---|---|---|
| 09:00–09:30 | **Keynote Address 3:** Trends and innovations in biodiversity data capture and data management. | Hannu Saarenmaa |
| 09:30–09:50 | **Plenary:** SANBI-GBIF, data sharing and growing institutional partnerships. | Fatima Parker-Allie |
| 09:50–10:10 | **Plenary:** Information systems and architecture (SANBI update session). | Brenda Daly |
| 10:10–10:30 | **Plenary:** Natural Science Collections Facility: data initiatives and progress. | Ian Engelbrecht |
| 10:30–11:00 | Tea/coffee | |

| 11:00–13:00 | **Parallel Session 1** | | **Parallel Session 2** | | |
|---|---|---|---|---|---|
| | **Community engagement to contribute to collection data management services of the National Biodiversity Information System (NBIS)** | Facilitated session (Approximately 1 hr)<br>B. Daly | **Standard and speed presentations**: **microbial diversity** | | |
| | | | **Talk 1:** | Updating the taxonomy of *Aspergillus, Penicillium* and *Talaromyces* in South Africa (**standard presentation**). | Cobus Visagie |
| | | | **Talk 2:** | Fungal biogeography and the use of publicly available data for answering biogeographic questions. | Mathew Harris |
| | | | **Talk3:** | Mycorrhizal diversity associated with endemic and endangered South African orchids of the genus, *Habenaria*. | Modjadji Makwela |
| | | | **Talk 4:** | Genome-informed *Bradyrhizobium* taxonomy: where to from here? | Juanita Avontuur |
| | | | **Talk 5:** | Both alpha- and beta-rhizobia occupy the root nodules of *Vachellia karroo* in South Africa | Chrizelle Beukes |

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|---|---|---|---|---|---|
| | **Parallel Session 1** (continued) | | | **Parallel Session 2** (continued) | |
| | | | | **Talk 6:** Isolation and identification of *Penicillium* species with potential phosphate solubilization activity from agricultural environments. | Aiden Visagie |
| | | | | **Talk 7:** Characterization of bacterial species in Steinkopf a communal farming area in South Africa: a closer look at pathogenesis. | Jodene Foster |
| | **Developing our biodiversity informatics science and human capital** | | Presentations and facilitated discussion (Approximately 1hr) | **Speed presentations**: **Taxonomy, systematics and DNA Barcoding** | |
| | **Talk 1:** Developing our biodiversity informatics science through curriculum and other initiatives. | | Fatima Parker-Allie | **Talk 8:** An assessment of the anatomical and genetic diversity of *Themeda triandra Forssk*. | Sinethemba Ntshangase |
| | | | | **Talk 9:** Predator–prey networks: using DNA barcodes to check what was for dinner. | Vimbai Siziba |
| | **Talk 2:** Youth Environmental Service (YES) Programme: empowering today's youth in the Northwest Province. | | Wentzel Pretorius & Maano Tshimang | **Talk 10:** A taxonomic review of *Englerodaphne* Gilg. (Thymelaeaceae: Thymelaeiodeae). | Dorcas Olaniyan |
| | | | | **Talk 11:** A systematic study of the southern African endemic genus *Sisyranthus*. | Khanyisile Shabangu |
| | | | | **Talk 12:** Systematics of southern African Anthemideae (Asteraceae): generic and subtribal relationships of Athanasiinae and Phymasperminae, and the placement of *Inulanthera*. | Solange Akimana |
| | | | | **Talk 13:** Evaluation of the nomenclatural status of the synonyms of *Enteromius anoplus* (Weber, 1987) (Teleostei, Cyprinidae). | Manda Kambikambi |
| | | | | **Talk 14:** Contributing towards resolving taxonomic issues on South African Arachnida fauna. | Thembile Khoza |
| 13:00–14:00 | Lunch | | | | |

| | Parallel Session 3 | | | Parallel Session 4 | | | Parallel Session 5 | | |
|---|---|---|---|---|---|---|---|---|---|
| 14:00–15:15 | **Standard presentations**: **Innovative tools and applications to support research and development** | | | **Speed presentations: Changes in the diversity and composition of arthropods and ants** | | | **Standard and speed presentations: using foundational biodiversity information for addressing global change challenges** | | |
| | **Talk 1:** | Conveyor-driven mass digitisation of herbarium sheets and pinned insects – properties and performance. | Hannu Saarenmaa | **Talk 1:** | Diversity and composition of ants and spiders along an increasing gradient of invasion by *Chromolaena odorata* at Buffelsdraai Landfill Conservancy, KwaZulu-Natal. | Sinenhlahla Mntambo | **Talk 1:** | DNA barcoding of freshwater fishes from southern Africa: assembling a reference library for topotypes to expedite species inventory (**standard presentation**). | Albert Chakona |
| | **Talk 2:** | The e-Flora of South Africa – restructuring data to comply with Darwin Core standards for inclusion into the World Flora Online. | Fhatani Ranwashe | **Talk 2:** | What structures ant communities along the Udzungwa mountains: species turnover or richness differences? | Caroline Kunene | **Talk 2:** | The branchiopod crustaceans of ephemeral wetlands in the Northern Cape (**standard presentation**). | Betsie Milne |
| | **Talk 3:** | Historical and repeat photographs as a source of qualitative and quantitative biodiversity information. | Hana Petersen | **Talk 3:** | Trade-offs: mechanisms that facilitate co-existence in the grassland ant communities | Nokubonga Thabethe | **Talk 3:** | The distribution of the biodiversity-threatening alien invasive commensal species of *Rattus* and the environmental and socioeconomic factors that may influence their presence in urban Gauteng Province, South Africa (**speed presentation**). | Lindelani Makuya |
| | **Talk 4:** | Developing fixed-point photography methodologies for assessing post-fire mountain fynbos vegetation succession as a tool for biodiversity management. | Kalei Alkalei | **Talk 4:** | Does soil acidity play a role in determining ant species diversity and composition in a mistbelt grassland of KwaZulu-Natal? | Lindiwe Khoza | **Talk 4:** | Alien plant survey of the Haenertsburg village, Limpopo province, South Africa (**speed presentation**). | Moleseng Moshobane |

| | Parallel Session 3 (continued) | | Parallel Session 4 (continued) | | Parallel Session 5 (continued) | |
|---|---|---|---|---|---|---|
| | **Talk 5:** The utilization of passive acoustic monitoring as a tool to determine anuran diversity in north-eastern Kwazulu-Natal, South Africa. | Wentzel Pretorius | **Talk 5:** Are arthropod communities changing with changing land-use patterns in communal areas? | Concilia Mukanga | **Talk 5:** Biodiversity co-benefits through reforestation for carbon sequestration (**speed presentation**). | Sbo Xolo |
| 15:15–15:30 | Tea/coffee | | | | | |

| | Parallel Session 6<br>Speed presentations | | Parallel Session 7<br>Working Session | | Parallel Session 8<br>Working Session | |
|---|---|---|---|---|---|---|
| 15:30–16:45 | **Monitoring and assessment of diversity in different habitats** | | 15:30–17:30 | Africa Biodiversity Challenge Project. Facilitator: Matthew Child | 15:30–17:30 | The South African node of the International Barcode of Life (SA-IBOL). Discussion on activities and structures for the node. Facilitators: Theresa Sethusa & Monica Mwale |
| | **Talk 1:** Diatoms associated with two South African kelp species: *Ecklonia maxima* and *Laminaria pallida*. | Serge Mayombo | | | | |
| | **Talk 2:** Assessing mammal diversity and the effectiveness of different methods for monitoring mammal diversity in diverse land tenures in a South African arid ecosystem. | Chloe Burt | | | | |

| | | |
|---|---|---|
| | **Parallel Session 6** (continued) | |
| | **Speed presentations: approaches to data generation for monitoring and assessment of biodiversity** | |
| | **Talk 3:** Taxonomic bias in foundational biodiversity data, research interests, extinction risk and cultural salience: A South African herpetofaunal perspective. | Fortunate Phaka |
| | **Talk 4:** Roads and users as a threat to wildlife conservation: modelling amphibian roadkill in Vhembe biosphere reserve (Soutpansberg conservancy), South Africa. | Thabo Hlatshwayo |
| | **Talk 5:** Creating a model for the prediction of roadkill Kruger National Park, South Africa. | Brilliant Mashao |
| | **Talk 6:** Dispersal of invasive *Lantana camara* by native bird species in KwaZulu-Natal, South Africa. | Nasiphi Bitani |
| | **Talk 7:** Dune fynbos–thicket vegetation of the Cape coast: proposing an updated and unified treatment (**standard presentation**). | Adriaan Grobler |
| | **Talk 8:** The influence of flow and temperature on mayfly (Ephemeroptera, Insecta) community structures in the Luvuvhu River catchment. | Pfani Ramulifho |
| | **Talk 9:** Highlights from the Global Environmental Change Programme of the Durban Research Action Partnership. | Preshnee Singh |
| 17:00–17:15 | **Plenary:** Key outcomes, reflections, and closure | Jeff Manuel |

## THURSDAY, 22 AUGUST 2019
## ROODEVALLEY FAIRCITY HOTEL, PRETORIA
### TRAINING DAY

| SANBI-GBIF<br>Data Management / Fitness for use of data training | FBIP Proposal Writing Workshop | BOLD Training Workshop |
|---|---|---|
| 08:00–17:00<br><br>The workshop will look at developing and improving data management skills within the community. Topics and software to be covered includes data organisation; OpenRefine will be used for data cleaning; and RStudio (Integrated Development Environment for R) will be used for data analysis and visualisation.<br><br>Presenters:<br>North West University and SANBI team including Fhatani Ranwashe and Mahlatse Kgatla | 08:00–13:00<br><br>This workshop will use a hands-on approach to illustrate the attributes of successful and unsuccessful FBIP proposals so that participants gain an understanding of the key requirements for both large and small project proposals and the evaluation process.<br><br>Presenter:<br>Michelle Hamer | 08:00–15:00<br><br>Barcode of Life Database – using BOLD for DNA barcode data analysis and identification of material. This workshop will illustrate some of the key functionalities of the Barcode of Life Database (BOLD).<br><br>Presenters:<br>Michelle van der Bank<br>Ronny Kabongo |
| 13:00–14:00 Lunch | | |

# ABSTRACTS

## Day One: Tuesday, 20 August 2019

### Plenary session

### KEYNOTE ADDRESS 1
### The 2019 Science, Technology and Innovation White Paper

*U. Rust*
Department of Science and Innovation; Urszula.Rust@dst.gov.za

The recent update of South Africa's science, technology and innovation (STI) policy, more than 20 years after the 1996 White Paper on Science and Technology, was prompted by rapid technological change and the need to expand the contribution of STI to government priorities. The 2019 White Paper on STI was based on both extensive review and consultation, and seeks to achieve the following, *inter alia*: entrenching a culture of valuing STI across society; increasing inclusivity, transformation and linkages (particularly with business and civil society) in the national system of innovation (NSI); improving policy coherence and budget coherence across government; developing a more enabling environment for innovation; expanding and transforming the research system; developing expanded STI human capabilities; accelerating the implementation of the pan-African STI agenda; increasing investment in the NSI; and improving funding efficiencies. The 2019 White Paper further takes on board learning from the emergent transformative innovation policy framing to address issues related to research ethics, social and economic justice, and environmental sustainability. The 2019 White Paper on STI will be implemented via a series of decadal plans, which will be developed in a collaborative manner, involving relevant NSI partners. To this end the Department of Science and Innovation (DSI) is planning to have topic-specific workshops with stakeholders in October 2019.

### KEYNOTE ADDRESS 2
### The IPBES Global Assessment is overwhelming! Can we have too much information and not enough data to spark action?

*K. Naicker*
Department of Environment, Forestry and Fisheries; KNaicker@environment.gov.za

The overwhelming evidence of the IPBES Global Assessment, from a wide range of different fields of knowledge, presents a dire scenario: 1 million plant and animal species threatened with extinction, many of which are threatened to go extinct within the next decade. The Assessment Report on Biodiversity and Ecosystem Services is the most comprehensive ever completed. It is the first intergovernmental report of its kind and builds on the landmark Millennium Ecosystem Assessment of 2005, introducing innovative ways of evaluating evidence. Despite this overwhelming evidence base, climate change deniers and now species extinction deniers exist, claiming that what resonates as a constant throughout all assessments is that data gaps exists and this runs the risk of questioning the validity of these assessments. What is the global fraternity doing to address the data gaps? The available evidence from the global assessment ranks the five key priority threats to nature in descending order of impact, which are: (i) changes in land and sea use; (ii) direct exploitation of organisms; (iii) climate change; (iv) pollution; and (v) invasive alien species. Do we have the necessary evidence to take concerted action on these priority threats? Or is it a case of improve the evidence base and fill the gaps. The new administration in South Africa, the Honourable Ms Barbara Creasy, advocates for a strong culture of evidence-based decision making. The data-, information- and knowledge-based sectors need to find innovative ways to fill the data gaps such that the information and the eventual knowledge that emerges from the data are scientifically and legally sound to hold up against the crises deniers.

## The Global Biodiversity Information Facility: a mega-science initiative coordinating biodiversity informatics through an open resource infrastructure

*F. Parker-Allie*
South African National Biodiversity Institute; F.Parker@sanbi.org.za

The Global Biodiversity Information Facility (GBIF) was established in 2001 (through a recommendation from the OECD) as a mega-science initiative with the aim of making the world's data freely and openly available. GBIF is an international network and research infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth. This talk will set out to give an overview of the GBIF technical platform, the data that is shared/mediated through GBIF, the tools that are available for use, and the capacity enhancement opportunities and partnerships of GBIF as well as other opportunities that the network can tap into to support biodiversity informatics science in South Africa. This includes the GBIF Young Researchers Award and the Ebbe Nielson Challenge.

In 2012 at the first Global Biodiversity Informatics Conference (GBIC), a number of key biodiversity informatics initiatives came together and developed a vision for biodiversity informatics. Here a framework called the Global Biodiversity Informatics Outlook was produced, which included focus areas i.e. data, culture, evidence and understanding, which can help align efforts of all stakeholders to enable an integrated understanding of biodiversity. In 2018 GBIC2 was held with the aim to discuss a roadmap towards a global integrated informatics infrastructure. This led to a proposal for a new alliance of institutions involved in the development and management of infrastructures supporting biodiversity data (to be understood in a broad sense, from species observations to earth observations). It was agreed that the GBIF will be acting as an ambassador. This talk will provide an overview of the platform and the vision for biodiversity informatics, which many of our South African institutions are contributing to.

## Biodiversity Heritage Library (BHL): a source of big data and analysis

*L. Monda[1*] & A.-L. Fourie[2#]*
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[2]South African National Biodiversity Institute (SANBI); #a.fourie@sanbi.org.za

The Biodiversity Heritage Library (BHL) is the world's largest open access digital library for biodiversity literature and archives. It is a consortium of natural history and botanical libraries that cooperate to digitise taxonomic literature, hence revolutionising global research by providing free, worldwide open access to knowledge about life on Earth. So far BHL has digitised over 200 000 volumes of taxonomic literature and identified over 178 million instances of species names; it includes over 50 million pages of text with over 80 terabytes of data spanning over 500 years of data collection, which makes the BHL a rich source of biodiversity big data complete with taxonomic and bibliographic metadata. The presentation will look at the types of data, access and uses of that data together with a short introduction to BHL and BHL Africa.

## Building a database of Lepidoptera–host–parasitoid associations recorded for the Afrotropical region

*H. Staude[1*], M. Maclean[2], A. Sharp[3], S. Mecenero[4], J. Pretorius[5], D. Edge[6], I. Sharp[7], S. van Noort[8,9] & R. Oberprieler[10]*

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[5]Department of Agriculture Faculty of Health and Environmental Science
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[9]Department of Biological Sciences, University of Cape Town
[10]CSIRO Australian National Insect Collection, Canberra, Australia

Plants, insect herbivores and their arthropod parasitoids and predators constitute over 75% of all multicellular life on earth. All three are crucial for ecosystem functioning. The effect of disruption of the ecological balance at these trophic levels can clearly be seen in the impact of alien invasive species. Yet even foundational knowledge on ecological interactions at these three trophic levels in southern Africa is largely lacking. A compilation of Lepidoptera–host associations recorded for the Afrotropical region (including all published records to date), conducted in 2012, registered such associations for less than 7% of the Lepidoptera species in southern Africa and for only a handful of Lepidoptera–parasitoid associations. To address this problem, at least for Lepidoptera–host–parasitoid interactions, LepSocAfrica launched a successful citizen science project called the Caterpillar Rearing Group (CRG). The CRG published its first results, an illustrated list of 962 Lepidoptera–host associations, in 2016 and a second, a similar exposition of 424 host associations of African Papilionoidea, a year later. A third such illustrated list, covering a further 544 species of Lepidoptera, is in preparation. These lists and the underlying database now comprise 10 636 records of Lepidoptera–host associations, spanning 13.6% of the Lepidoptera fauna of southern Africa and effectively doubling, in seven years, the amount of data that had been accumulated in over a century before 2012. Over 600 Lepidoptera–parasitoid associations have also now been recorded. To enhance the analytical value and accuracy of the database, it is currently being expanded by adding fields to record relevant ecological and biogeographical data as well as levels of taxonomic accuracy to reflect an up-to-date phylogeny of the taxa at all three trophic levels. An appeal is made for enhanced collaboration between the CRG and similar organisations covering Lepidoptera–host–parasitoid associations in other faunistic regions of the world.

## Is South Africa ready for metabarcoding?

*S. Willows-Munro*
Conservation Genetics Lab, School of Life Sciences, University of KwaZulu-Natal, willows-munro@ukzn.ac.za

Metabarcoding is a new method of rapid biodiversity assessment that combines two technologies: DNA-based identification (DNA barcoding) and high-throughput DNA sequencing. It uses universal PCR primers to mass-amplify standard DNA barcodes from whole collections of organisms or from environmental DNA. It has the potential to revolutionise biodiversity research. But is South Africa ready to embrace this new technology? In this talk I provide an overview of the status of the DNA barcode reference library in South Africa. Using examples from some recent metabarcoding studies in my lab, I will provide comment on the future of metabarcoding in South Africa.

# Plenary:
# Foundational Biodiversity Information Programme (FBIP) – linking funding priorities with national projects and initiatives

## FBIP: an overview of the programme funding approach, update of grants awarded and capacity development strategies

*L. Pauw*
South African National Biodiversity Institute; l.pauw@sanbi.org.za

The Department of Science and Technology (DST) established the Foundational Biodiversity Information Programme (FBIP) in 2013 in recognition that sustainable use and management of South Africa's biodiversity require a solid knowledge base and access to relevant information. A number of challenges have limited the use of the data and knowledge generated through research for decision-making and therefore, the mandate of the FBIP is to fill the large gaps in our knowledge by means of a strategic approach and to unblock the value chain for foundational biodiversity data generation. Research grant-making is one of the main mechanisms for achieving the objectives of the FBIP and the FBIP provides grants for the generation of knowledge related to documenting South Africa's biodiversity, mobilisation of species occurrence or distribution data, generation of DNA barcode data that will allow identification of biological material, and compilation of descriptive information on species. The grants must result in the release of data to the FBIP/SANBI for archiving, integration, management and dissemination and from the start of the Programme, the FBIP has funded 121 projects. To ensure appropriate capacity for biodiversity knowledge generation, dissemination and application, the FBIP has several capacity developing initiatives. This presentation will provide an overview of the programme and progress made.

## An update on Foundational Biodiversity Information Programme (FBIP) generated data

*M.M. Kgatla*
South African National Biodiversity Institute (SANBI); M.Kgatla@sanbi.org.za

Proper planning for biodiversity conservation requires the support of quality and reliable primary data. The FBIP has been funding research in South Africa specifically for generating primary data, including observation and specimen data. Accurate identification of specimens is a critical aspect of data and so DNA barcoding and taxonomic research are also supported. All data generated through the FBIP-funded projects have to be provided to the SANBI and the data sets must be made openly accessible. To date the FBIP has funded five large projects: the SeaKeys project, which generated more than 145 589 records; the BioGaps project, which is involved in surveys of the Karoo as well as mobilisation of data from specimens in collections; a survey of animals in the forests of the Eastern Cape, Snapshot Safari, which will generate large numbers of mammal camera trap records; and the most recent funded project is on microbiomes of two major crops in South Africa. FBIP has also funded approximately 120 small projects. The total number of occurrence records generated to date is more than 319 199 and more records of data is anticipated as projects provide their data sets. These data can help improve spatial planning for biodiversity conservation.

## Informal forest product harvesting and avian diversity in the Eastern Cape

*M.I. Cherry*, J. Leaver & J. Mulvaney*
Department of Botany and Zoology, Stellenbosch University; *mic@sun.ac.za

Forest management aims to balance the needs of resource users and the ecological integrity of forests. While South Africa has legislated management policies to achieve this, implementation is lacking, resulting in unregulated resource use compromising forest biodiversity. However, there is little information regarding resource use since regulations were promulgated twelve years ago. This study reports on the current extent of forest product harvesting in the Eastern Cape and its effects on avian diversity as a proxy for faunal biodiversity. Extraction rates and target species of key products, namely poles, timber and bark, were assessed across six forests, representing five ecotypes. Variation in avian functional diversity was driven by broad-scale differences in forest ecotype, as well as harvesting disturbances, while taxonomic richness was unaffected by harvesting disturbance. Harvesting variably affected different measures of avian functional diversity, with functional evenness negatively affected by timber harvesting; and functional dispersion negatively affected by both pole and bark harvesting. Regionally, harvest intensities indicated low to moderate levels of use, with considerable variation in resource use at the forest-scale, illustrating the importance of site-specific assessments. Resource use was species-specific, indicating that sustainability is dependent on the ecology of preferred species. Of concern was widespread commercial-scale bark harvesting; and relatively high timber extraction from a threatened lowland Pondoland forest ecotype. We urge more stringent monitoring of resource use, and implementation of existing regulations. In the case of current harvesting of timber and bark, we recommend legalisation for commercial purposes to promote regulation.

## BioGaps: Filling biodiversity information gaps to support development decision making in the Karoo

*D. Raimondo*, C. Poole & T. Sethusa*
South African National Biodiversity Institute; *d.raimondo@sanbi.org.za

The Karoo is seen as an important development area for South Africa and there needs to be responsible decision-making around developments such as shale gas exploration, farming, mining, renewable energy infrastructure and the Square Kilometre Array. In 2014 the Karoo was poorly surveyed for biodiversity and there were large gaps in our understanding of which species occurred in which parts of the Karoo. This hampered efforts to determine priority habitats that may be sensitive to future proposed changes in land-use. As a result SANBI formed a consortium of 18 institutions and applied for, and received, an integrated Foundational Biodiversity Information Programme grant to implement the Karoo BioGaps Project between 2015 and 2018. The project has received a no cost extension of one year and is busy finalising all project outputs. In this presentation we will demonstrate what data were mobilised during the course of the project and which products have been completed. We will also present the lessons learnt during the implementation phase of the project to share with others who are either currently implementing FBIP projects or plan to apply for these.

## Snapshot Safari: progress to date and future directions

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South Africa is one of the most biodiversity rich countries in the world. However, information on the conservation status of many species is limited. For this reason, Nelson Mandela University started Snapshot Safari–South Africa, an international collaborative initiative formed to systematically map the diversity and ecological dynamics of South African mammals to inform conservation planning. We will present an update of this project and the research questions we are addressing. Among other things, we currently have surveyed 21 locations across the country, of which 16 are permanent sites for monitoring purposes. This represents a total of 648 permanent sites (independent cameras sites) and 165 roaming sites. The millions of images produced are classified through a combination of citizen science and machine learning. Thus far, volunteers have processed ten locations, with five sites close to being finalised (Karoo, Kgalagadi, Kruger, Pilanesberg and Gondwana). More than 20 graduate theses are using this data. In May 2019, Snapshot South Africa organised its first workshop to visualise future collaboration and research questions. The results from this initiative will not only help to understand the distribution, diversity and ecology of mammals, but will also serve to inform conservation plans and management in South Africa.

## Soil *Fusarium* survey in the Great Karoo biome of South Africa

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South Africa, as a mega-diverse country, has invested significant resources in documenting its above-ground flora and fauna. However, similar research on soil organisms, specifically soil fungi, has been fragmented and poorly integrated. The soil ecosystem plays host to some of the most important plant, human and animal fungal pathogens documented. In the past, these have been mainly identified based on morphology. This is time consuming, and commonly leads to erroneous identifications and does not provide a platform for different research sectors to use. A public, accessible platform for different research sectors is required to submit and compare taxonomic data of fungal isolates. Improving our understanding of soil ecosystems in South Africa is of great strategic importance since it is the basis for the vast majority of our agricultural production and an essential ecosystem service for rural communities. This small FBIP grant based project expanded the current databases of South African phytopathogenic and soil fungi with 800 isolates and 500 DNA barcodes from the unique Great Karoo biome.

## Developing an operational framework for unlocking coastal plankton biodiversity information: progress, challenges and the ambitious march towards an informed future

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The contribution of plankton to biogeochemical cycling and conservation of energy within aquatic food webs is widely recognised, as is their usefulness for monitoring changing environmental conditions, including those directly related to climate change. Their small size, rapid turn-over, high abundance and responsiveness to environmental change makes plankton popular model organisms for topics central to both theoretical and applied ecology. However, even the most basic ecological questions demand some understanding of species occurrences, distribution, abundance and interactions, yet this information is not always readily available and generally cumbersome to generate, given our ongoing reliance on traditional methods for species identification. Limited primary biodiversity information has repercussions for research, management and policy. Without it we cannot contribute to global standardisation efforts such as essential biodiversity variable derivations, which is so crucial in the study, reporting and management of biodiversity change on both regional and global scales. The situation for coastal pelagic ecosystems is no exception. Available biodiversity information for coastal plankton is sorely lacking, which limits our ability to monitor ecosystem states, understand their dynamics and detect change. Without such systems knowledge our ability to accurately forecast future scenarios against altered climate states will remain limited. Herewith, we present an operational framework aimed at addressing key challenges currently hindering the generation and implementation of coastal plankton biodiversity information. We base concepts on Long-term Ecological Research initiatives operational within the Algoa Bay Sentinel Site and share our ambitious vision for a national mandate.

## Strengthening biodiversity informatics and data mobilisation efforts nationally and regionally through SANBI-GBIF and the African Coordinating Mechanism

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Africa is one of the most megadiverse continents in the world. It boasts a substantial share of the world's biodiversity including one-fifth of all mammal species and one-quarter of all bird species. Despite this, African species are dramatically underrepresented in the world's freely accessible biodiversity information resources. It was reported that only 4% of the >1 billion records available through the Global Biodiversity Information Facility (GBIF) concern African biodiversity, the majority of which were published by non-African institutions. Even within Africa, distributional biodiversity databases exhibit strong spatial bias due to uneven efforts in sampling, storing and sharing data, which may, in turn, reflect high regional variation in capacity, funding and political will.

SANBI is a knowledge-based organisation, here biodiversity information is the key resource that drives research and innovation, informs planning and policy development processes, informs decisions and is the basis to evaluate progress and impact. It is therefore important that biodiversity and biodiversity information is managed as a strategic asset that will leverage shared value supporting sustainable decisions towards the broader developmental objectives. In light of this SANBI-GBIF has developed a regional engagement strategy and has been identified to lead the regional African Coordinating Mechanism (ACM) for biodiversity informatics on the African continent. The ACM is the ultimate vision for a formal regional structure for biodiversity information management and has been identified as far back as 2010, by the GBIF Africa Nodes, as a requirement to foster the implementation of the GBIF strategic plan, in Africa.

Six strategic priority areas to advance the biodiversity informatics efforts (driven by the GBIF-Africa Nodes and strategically identified partners) have been identified, across the value chain to support the generation, management, publication and use of biodiversity information for conservation, decision-making and sustainable development in Africa. Capacity development has also been identified as critical to ensure advancement the biodiversity informatics agenda.

## The African Open Science Platform (AOSP): fostering a culture of open data within African national systems of innovation

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Concurrent advances towards the 4th Industrial Revolution such as Artificial Intelligence (AI), the Internet of Things (IoT) and robotics are expected to enable tremendous innovations and fundamentally transform science, business, government and society – also in Africa. Scientific advances, spearheaded by an explosion of data generated through digitally connected devices, will only be possible if governments and organisations are aligned, prepared and geared towards collaboration and sharing of infrastructure and other resources. To understand where we want to go, and what is needed to get there, the South African Department of Science and Technology, through the National Research Foundation, made available funding and mandated the Academy of Science of South Africa to conduct a landscape study to identify the status of data initiatives and sharing on the continent.

This paper will share selected findings from the report, including challenges and opportunities, to stimulate thinking on the role of various stakeholders and research communities – also in biodiversity – to make sure data remain FAIR. Frameworks to guide policy- and decision-makers in terms of open data policy, capacity building, incentives for sharing, and the required infrastructure to enable data sharing, will further be presented. AOSP follows on existing initiatives and strategies elsewhere in the world, such as the e-infrastructure work by the Joint Information Systems Committee (JISC), US National Science Foundation (NSF), the European Open Science Cloud (EOSC), Compute Canada, the Australian Research Data Commons (ARDC) and the Southern African Development Community (SADC). The future AOSP is expected to position the African continent alongside these major initiatives, advancing science even further, to the benefit of all.

## Lessons learned from stimulating biodiversity informatics networks through the *African Biodiversity Challenge*

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The *African Biodiversity Challenge* was a competition between four African countries to mobilise policy-relevant data. The project was unique in that it incentivised the self-organisation of inter-institutional teams and provided no funding upfront to conduct the work. Over a 16 month period (Aug 2017–Dec 2018), the teams mobilised 47 644 records in total, spanning all data classes and multiple taxa, and succeeded in hosting inaugural Biodiversity Information Management Forums (BIMFs) to connect with broader stakeholder groups. Overall, the ABC methodology was a proven success and demonstrated that many hurdles can be overcome by working strategically through a network of partners. However, the translation of data into information products and thus into policy remains elusive, and the sustainability of the national endeavours requires consolidating potential partnerships. Here we present a summary of the lessons learnt from the project and a set of recommendations for future initiatives on the continent. Central tenets to a more effective project design include mapping the internal workflows and existing information systems of target institutions to facilitate incremental change; designing relevant data products *a priori* and mobilising specific datasets; and interspersing formal training events with more regular practice sessions to embed skillsets.

## Enhancing the accessibility of biodiversity data in Malawi through partnerships and biodiversity information management tools

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Natural habitats in Malawi are under threat due to degradation and conversion, climate change, invasive alien species and overexploitation, which results in biodiversity loss. However, biodiversity is not considered in protected area establishment, spatial development frameworks, national development plans and land-use management planning because biodiversity data are not accessible to scientists or decision-makers. Through the African Biodiversity Challenge, a partnership of four institutions is attempting to catalogue what biodiversity data exist in Malawi, along with their current accessibility, and to mobilise potentially policy-relevant data. These efforts are the essential foundation to enhancing accessibility and use of this information. In this presentation, we summarise the history and current status of biodiversity data in Malawi and the systems/databases used to manage such data. Furthermore, we provide examples of the uses of published datasets as well as a roadmap towards strengthening the role of biodiversity information management tools to build a data–science–policy value chain in Malawi.

## Enhancing biodiversity data mobilisation, management and utilisation in off reserve areas in Ghana: using CREMAs as a model

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Biodiversity information is a key resource that drives research and innovation; informs planning and policy-development; and assists reporting and decision-making. It has both national and international relevance. Hence, biodiversity is critical to advance the sustainable development agenda. As such, the environmental sector must incorporate diverse data sources and include data from cross-sectoral government departments to make data available quickly enough to ensure that the data cycle matches the decision cycle.

Community Resource Management Areas (CREMAs) are established with the guiding principle that, once communities have access, control and benefit from value addition to their natural resources, it will be an incentive to sustainable management. The lack of reliable data to quantify baseline biodiversity patterns or evaluate local ecosystem services of the CREMA landscape adversely affects management. Robust biodiversity data are therefore needed to improve decision making within the CREMA landscape. Hence, twelve datasets comprising 22 307 records were mobilised and published under the African Biodiversity Challenge (ABC) to address this data challenge.

The datasets were highly policy-relevant and have already been used by multiple stakeholders including updating management plans of the CREMAs and contribution to the development of National Invasive Species Strategic Plan in Ghana.

## Keynote Address 3
## Trends and innovations in biodiversity data capture and data management

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Digitalisation of society is progressing fast. In science this has resulted in renewed interest in data driven approaches using drones, video surveillance, camera traps, artificial intelligence, big data, DNA meta-barcoding of entire ecosystems, etc., to name a few. Mass-digitisation of entire scientific collections has also become possible. There are plans to digitise tens of millions of specimens each year and make their images and data freely and openly available in near real time. New major research infrastructures and initiatives such as the Distributed System of Scientific Collections (DiSSCo) in Europe are being shaped to seize these opportunities and coordinate the developments. How to manage such petabyte-scale data and exploit it for new science and innovations will be the challenge for the next decade. The presentation takes stock of these developments in particular from the view of boosting worldwide collaboration.

## SANBI-GBIF, data sharing and growing institutional partnerships

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SANBI is mandated to monitor and report on the state of biodiversity within South Africa. It has a key role in the coordination of biodiversity data for the country, through the National Environmental Management Biodiversity Act. To perform this function, effective engagements with Partner organisations are critically important, as SANBI relies on biodiversity data from a wide range of data providers, from provincial conservation agencies, national parks, to individual landowners and the museum biodiversity collections community to large institutions.

SANBI hosts the South African Node of GBIF (SANBI-GBIF), which plays a fundamental role with regards to data coordination and publishing with our partner institutions. In this talk I will provide an update of data mobilisation activities of the Node. SANBI is also embarking on a process to standardise and update all data-sharing agreements with data partners. To support this process, SANBI has recently produced a new Data Sharing Agreement that is signed at the institutional level. Thus, moving away from a project based approach, which allows SANBI to coordinate data from partner institutions much more efficiently.

## Information systems and architecture (SANBI update session)

*B. Daly (facilitated session)*
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In order for the South African National Biodiversity Institute (SANBI) to meet its biodiversity monitoring and reporting requirements, it is vital that new sources of data are enabled and that currently accessible data is integrated. To accomplish this, new biodiversity information tools are required. This presentation provides progress on the proposed data sharing architecture for a National Biodiversity Information System (NBIS) being developed by SANBI and details on the new biodiversity information tools being developed. These include a Species Red List Assessment Tool and Ecological Database.

## The Natural Science Collections Facility: data initiatives and progress

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The Natural Science Collections Facility (NSCF) is well under way with one its main goals being the mobilisation of high quality specimen data from herbarium and museum collections around the country. Towards this end the NSCF is developing a set of data standards to facilitate easier access to and sharing of data. This has proven far from a simple process. This presentation will review progress in the development of these data standards for natural science collections, as well as some of the challenges encountered. These challenges range from a lack of clarity of some Darwin Core terms, from which the standards are derived, to resistance from institutions and individuals to changing their current practice. The value of standards will be discussed, as well a future vision for the natural history institutions where any data exchange is based on an accepted standard. Attitudes to data sharing also remain a potential impediment, and the lessons learned here in the last year will be reviewed.

## Community engagement to contribute to collection data management services of the National Biodiversity Information System (NBIS)

### Community engagement to contribute to collection data management services of the National Biodiversity Information System (NBIS)

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Sharing primary biodiversity data is fundamental to advancing science, sustainable practice, good policy and ultimately better decision-making. To achieve this goal we are dependent on the willingness and practices of data providers. Building on the investment being made by the National Science Collection Facility (NSCF), SANBI is currently working towards aggregating these biodiversity collections (museums and herbaria) in South Africa so integrating a great deal of biodiversity data for environmental management and priority setting.

- The success of data sharing lies in the attitudes and practices of museums and herbaria and this facilitated session hopes to address the following points:
- Development of appropriate infrastructure to improve data sharing.
- Intention of the data sharing agreement.

Constraints hindering the sharing of primary biodiversity data identified at previous Biodiversity Information Management Forums (BIMFs).

## Developing our biodiversity information science and human capital

### Developing our Biodiversity Informatics science through curriculum and other initiatives

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Biodiversity Informatics (BDI) is a new and developing field of science. It deals with the interrelated challenges of collection, collation, integration, analysis, prediction and dissemination of data and information related to the biotic resources of the Earth. With many critical areas of applied research linked to human well-being affected by such a new and dynamically evolving field, the need for increased capacity enhancement in this area of science has been identified as important.

This talk will highlight a holistic approach to capacity building and look at different pathways SANBI-GBIF is taking to grow capacity in biodiversity informatics in the country. This includes efforts to establish a Research Chair; a look at the various training events, which has been conducted through the SANBI-GBIF Node and the Biodiversity Information Management team for over a decade; developing curriculum and growing communities of practice in specific topics and the roll-out of the annual forum, which supports growing the network of stakeholders engaged in biodiversity information management. It will also highlight international opportunities and re-usable training materials available to the national community to grow our biodiversity informatics science.

### Youth Environmental Service (YES) Programme: empowering today's youth in the Northwest Province

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As part of community youth empowerment and development, the former Department of Environmental Affairs (DEA), now Department of Environment, Forestry and Fisheries (DEFF), appointed the North-West University as a training provider for the Youth Environmental Service (YES) programme in the North-West Province. Several municipalities within the province have been selected in which young learners from previously disadvantaged communities were selected from each of the selected municipalities. This exciting two-year project that has been running since October 2018 includes a total 260 participants between the age 18 and 35 years. As part of this YES programme, the North-West University's Centre for Environmental Management (CEM) is currently providing short courses in which learners are exposed to different environmental management–related subjects. These short courses cover Waste Management in the context of the green economy; understanding aquatic ecosystems and implementing integrated catchment planning; understanding indigenous plant management and implementing problem plant control programmes; as well as planning and i implementation of soil erosion control and veld burning operations. The overall outcome of this programme is to provide the youth with knowledge and skills that will empower them to realise a career opportunity in the environmental sector and to be active participants in their societies and economy. Furthermore, the knowledge acquired through this programme can help the students decide whether or not to pursue university studies in the field of environmental science. To date, positive feedback has been received from the delegates who have completed the training programme.

## Updating the taxonomy of *Aspergillus, Penicillium* and *Talaromyces* in South Africa

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South Africa is a biodiversity hotspot, with many new fungi discovered annually. Unfortunately, most of our fungal knowledge is solely based on traditional morphology. Recent taxonomic changes in *Aspergillus*, *Penicillium* and *Talaromyces*, combined with their diverse nature and economic importance necessitated the modernisation and updating of local knowledge. As a result, this FBIP-funded project aimed to re-identify strains in the National Collection of Fungi (NCF-PPRI) and the Medical Research Council (MRC) using modern sequencing methods. A total of 588 strains were re-identified to 186 species (70 *Aspergillus*, 90 *Penicillium* and 26 *Talaromyces*) based on 1 057 DNA sequences generated. Twenty-seven of these represented new species (8 *Aspergillus*, 15 *Penicillium* and 4 *Talaromyces*) and will be formally described in due course. Additionally, a number of strains belonged to species currently known from only a single type strain, while many sequences captured infraspecific variations for well-known species. This type of data is crucial for more robust species delineations and will make future culture dependent and independent identifications easier. South Africa with its diverse communities can thus make significant international contributions to a better understanding of these important genera.

## Fungal biogeography and the use of publicly available data for answering biogeographic questions

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Microbes represent the majority of species on earth. Yet, our understanding of how microbes are distributed across space and through time, i.e. microbial biogeography, remains poorly understood, particularly at large (continental and global) scales. Recently, the widely adopted use of next-generation sequencing technologies and the ability to sequence microbial communities directly from environmental samples have resulted in the rapid accumulation of high-quality community datasets. These datasets are uploaded onto publicly accessible platforms, e.g. NCBI's GenBank, and thus represent a potential source of metadata (e.g. locality records) with which to explore biogeographic patterns. DNA sequence data and linked metadata of plant-associated fungal communities were extracted from Genbank. The metadata of these samples were investigated to assess the completeness of the user-defined metadata, as well as its geographic coverage, habitat origin, plant organ of host and host identity, amongst others. While the sequence information contained on these public repositories is considered to be of high quality, the submitter-defined metadata of the samples is of a lower quality or incomplete, limiting the re-use of the high-quality sequence data. We conclude that, while microbial biogeographic studies are now, more than ever, poised to make major contributions to biogeographic theory, good quality and complete metadata are essential to maximise the value of, and allow novel insights from, DNA sequence data.

## Mycorrhizal diversity associated with endemic and endangered South African orchids of the genus, *Habenaria*

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Global orchid populations are drastically declining due to human-induced factors such as habitat destruction and over-collection. Orchids are not easily propagated due to their obligate dependence on mycorrhizal fungi for their germination and growth. These fungi provide nutrients to orchids, especially during early development. Orchid conservation efforts employing mycorrhizae-based ex-situ propagation in tandem with in situ conservation have been successful worldwide. However, ex situ propagation requires knowledge on the specific mycorrhizae associated with an orchid. In southern Africa, over 471 orchid species are endemic to the region and many of them are of conservation concern. However, knowledge on their mycorrhizal associates is limited. The purpose of this study is therefore to bridge this knowledge gap by identifying orchid mycorrhizae associated with two South African orchid species, *Habenaria barbertonii* and *H. epipactidea*. Orchid roots were collected on a property in Pretoria. Positive mycorrhizal interactions were confirmed in the roots using microscopy and fungal isolations. To capture a higher diversity of mycorrhizae, DNA barcoding techniques (molecular cloning and illumina HiSeq 2500 metabarcoding) were used. Our study resulted in a substantial list of potential mycorrhizae represented by families from the Basidiomycota (Ceratobasidiaceae, Serendipitaceae and Tulasnellaceae) and Ascomycota (Pezizaceae). Our results also provide an initial step in implementing ex situ conservation strategies for South African orchids.

## Genome-informed *Bradyrhizobium* taxonomy: where to from here?

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*Bradyrhizobium* is a diverse and cosmopolitan genus of bacteria, which can nodulate a variety of geographically distributed legumes. Apart from their beneficial symbiotic abilities, members of this genus can live endophytically with legume and non-legume hosts, while others also have photosynthetic abilities. This genetic diversity complicates the taxonomy of the genus in terms of placement and inclusion of species within the group. However, the availability of whole genome sequence data has proven to be a valuable resource to simplify the taxonomy of *Bradyrhizobium*. This study therefore aimed to use genome data to evaluate the taxonomic cohesion of *Bradyrhizobium* in light of their diverse lifestyles. This was achieved by using all available *Bradyrhizobium* genome data to infer the first robust phylogeny of this genus. Our results showed that *Bradyrhizobium* is a monophyletic assemblage separated into seven lineages, three of which correspond to the *B. japonicum, B. elkanii* and photosynthetic super-groups. Further analyses of key lifestyle traits such as nodulation, nitrogen fixation and photosynthesis were also investigated. These traits exhibited complex evolutionary histories and their distribution suggested combined effects of both vertical inheritance from a common ancestor and horizontal gene transfer from other sources outside the genus. Therefore, this study emphasizes the importance of genome information and their use in taxonomic and evolutionary studies.

## Both Alpha- and Beta-rhizobia occupy the root nodules of *Vachellia karroo* in South Africa

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*Vachellia karroo* (formerly *Acacia karroo*), like many other legumes, can interact with specific soil bacteria (called rhizobia) to form nitrogen-fixing root nodules. Predominantly rhizobia are members of the Alphaproteobacteria, while South Africa has also become known as a centre of diversity for rhizobia in the Betaproteobacteria (of which members were only discovered in 2001). Before this study there was no information available regarding the identity or diversity of *V. karroo*-associated rhizobia in South Africa. Our aims were therefore to collect rhizobia associated with this host across a diverse range of habitats (as *V. karroo* is also important to bush encroachment), to investigate the identity of these nodule inhabitants (via 16S rRNA sequencing) and putatively determine their species identity (by means of *recA* phylogenies) as well as confirming their ability to nodulate. We obtained 88 nodule-occupying bacterial cultures from 28 locations across seven biomes. Our results showed that *V. karroo* can associate with rhizobia in the Alphaproteobacteria (*Ensifer*, *Mesorhizobium*, *Rhizobium* and *Bradyrhizobium*) as well as Betaproteobacteria (*Paraburkholderia*), showing that *V. karroo* is a promiscuous host and this ability could be helpful when invading a new habitat.

## Isolation and identification of *Penicillium* species with potential phosphate solubilization activity from agricultural environments

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Modern fungal diversity studies are relatively underexplored in the context of South African Agriculture, yet these communities are crucial to the entire process. The Western Cape is a *Penicillium* biodiversity hotspot of South Africa, often dominating fungal communities. This project is focused on determining *Penicillium* diversity and its role in agricultural soils. Isolations were made from soil collected from several research farms in South Africa, used for wheat (Western Cape) and maize (Free State) production. These will be identified based on morphological characterisation and DNA sequencing using a polyphasic species concept. Preliminary isolations resulted in 125 strains. Of these, a total of 42 Beta-tubulin sequences have so far been acquired. This phylogenetic characterisation placed these 42 strains into 12 species, representing a higher than anticipated diversity. Morphological characterisation is ongoing. Eventually this project will focus on the identification of a *Penicillium* species with good phosphate solubilization (PS) activity. This PS activity is a characteristic that is highly valued in bio-fertiliser applications. This and species diversity data ties into a larger project studying the effect of different agricultural practices on the microbial communities present in the soil.

## Characterization of bacterial species in Steinkopf, a communal farming area in South Africa: a closer look at pathogenesis

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The human population in sub-Saharan Africa has been drastically increasing due to decreases in mortality rates and increases in average human age; in turn increasing pressure placed on agricultural production. One unintended consequence has been the emergence, resurgence and spread of transboundary animal and zoonotic diseases. This study focused on the communal farming area of Steinkopf in the semi-arid Namaqualand region of South Africa, with a communal land tenure and a mixed farming system (sheep and goats). The study aimed to identify and characterise the bacterial microbial communities found in the topsoil layer and faecal matter (dung) within the winter and summer rainfall regions of Steinkopf using Next-generation sequencing; amplifying 16S rRNA targeting the V3-V4 hypervariable regions, and further aiming to determine if pathogenesis is present. A total of 37 phyla, 634 genera and 1 pathogenic species (*Escherichia albertii*) were identified and alpha diversity indices showed a variation in species diversity, evenness and richness between soil and dung as well as summer versus winter samples; with summer samples having greater bacterial abundance and diversity. This study adds knowledge to both environmental bacterial microbiota and potential pathogenesis within this particular rangeland and showcases the usefulness of using a high-throughput sequencing platform like Next-generation sequencing.

## An assessment of the anatomical and genetic diversity of *Themeda triandra* Forssk.

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Polymorphism observed in the ecologically and economically important grass *Themeda triandra* Forssk. has led to a number of studies being conducted to assess its taxonomic status, mostly on the ecology, cytology and seed biology of the species. The current study aims to close the gap on genetic and anatomical diversity of *T. triandra.* To assess genetic diversity, two nuclear DNA regions were employed: Internal Transcribed Spacer (ITS) and External Transcribed Spacer (ETS). To assess anatomy, Scanning Electron Microscopy and Light Microscopy techniques were employed. Both ITS and ETS were almost identical among the South African specimens (n=89), but Australian specimens (n=8) were variable with four haplotypes. Anatomical results also showed little diversity within South African specimens, with variable characters only diagnostic at specimen level. These results imply that polymorphism observed in *T. triandra* is a result of differences in environmental conditions i.e. phenotypic plasticity such as is found in an ochlospecies complex *sensu* Cronk (1998). Anatomical and genetic data provide reliable taxonomic results at species level; however, more studies need to be conducted on *T. triandra* to further improve the taxonomy.

## Predator–prey networks: using DNA barcodes to check what was for dinner

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Predator–prey interactions are important ecological relationships affecting community structure and composition. Studying predator–prey interactions is also an important component of monitoring ecosystem health as this relationship is one of the main determinants of energy flow through the ecosystem. South Africa is home to some of Africa's most enigmatic predators. Studying what prey they are consuming can often be a difficult task. DNA barcoding and the field of metabarcoding can offer scientists a new tool in studying predator–prey associations through analysis of scat. Without a comprehensive reference library of potential prey the impact of this research is limited. In this talk I will discuss the current status of the prey reference library for medium-sized carnivores in South Africa. I will also discuss some of the challenges involved in metabarcoding scat

## A taxonomic review of *Englerodaphne* Gilg. (Thymelaeaceae: Thymelaeiodeae)

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*Englerodaphne* Gilg. (Thymelaeaceae: Thymelaeiodeae) is a member of tribe Gnidieae subtribe Gnidiinae. It comprises three species, two of which are endemic to southern Africa and the third disjunct with tropical east Africa. The taxonomy of *Englerodaphne* has not been fully reviewed since its current circumscription by Philips in 1951. We provide a revision of *Englerodaphne* and consolidate the taxonomic information available for the species. *Englerodaphne* is distinguished from other genera in subfamily Thymelaeiodeae by its broad membranous leaves, ebracteate inflorescences and flowers with four petaloid scales each divided to near the base into two narrow segments. Each species is described and illustrated, with notes on nomenclature, typification, ecology and distribution. A key is provided to distinguish among the species. The three species differ in the type of inflorescence, foliage and hypanthium indumentum, flower colour and hypanthium length, and details of the petaloid scales.

## A systematic study of the southern African endemic genus *Sisyranthus*

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The poorly known genus *Sisyranthus* is placed in the tribe Ceropegieae and subtribe Anisotominae (Apocynaceae–Asclepiadoideae). Plants have fertile parts hidden in the tube of the flowers and their cryptic habit and small size of their flowers make it difficult to identify individuals. The genus was first described by Meyer in 1837 and last revised in Flora Capensis (1908). Since then, only one new species has been described. Currently it comprises 13 recognised species found in the grasslands of southern Africa with one species restricted to Zimbabwe. In existing phylogenies, the subtribe Anisotominae has been under-sampled, and broader sampling of southern African taxa is required to resolve relationships within and between *Sisyranthus* and its close allies. Furthermore, the existing key is difficult to use, leading to confusing identifications. In this study, all *Sisyranthus* species, together with representatives within Anisotominae, were barcoded, using the core barcoding regions *rbcLa* and *matK*, along with sequence data from two nuclear markers (ITS and ETS) and two plastid regions ( *trnL-F*, and *ycf1*. The resulting phylogeny indicates that *Sisyranthus* represent a well-supported monophyletic clade within the Anisotominae with the genera *Anisotoma* and *Riocreuxia* moderately to strongly supported as sister clades. However, within *Sisyranthus,* several taxa were reduced to polytomies due to a lack of informative sequence variation. The key produced is a crucial step to accurately identify *Sisyranthus* species in the field. Furthermore, this study also provides the first step towards a much-needed revision of *Sisyranthus*.

## Systematics of southern African Anthemideae (Asteraceae): generic and subtribal relationships of Athanasiinae and Phymasperminae, and the placement of *Inulanthera*

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Phylogenetic analyses of the tribe Anthemideae have demonstrated that the southern African contingent of this tribe represent its earliest diverging lineages and, as such, southern Africa has been hypothesised as the cradle of this now largely Northern Hemisphere tribe. Ongoing studies have focused on unravelling relationships among the southern African subtribes, especially Athanasiinae and Phymasperminae. Previous studies based on limited sampling have indicated that the circumscriptions of these two subtribes are in need of re-assessment as Athanasiinae may not be monophyletic and the placement of Phymasperminae differs between nuclear and plastid datasets. The present study aimed at expanding the datasets for these two subtribes based on two nuclear (ITS and ETS) and two chloroplast (*rpl32-trnL* and *3'rps16-5'trnK*) regions, including a representative sampling from other subtribes within Anthemideae. The data indicate that Phymasperminae is embedded within Anthanasiinae, and that the two subtribes form a monophyletic group indicating that they may be better treated as a single subtribe. Within Phymasperminae, *Gymnopentzia* and *Eumorphia* should be included within *Phymaspermum*. In Athanasiinae *Asaemia* was placed within *Athanasia* contrary to other studies indicating that it does not warrant generic status. *Inulanthera* was shown to have a fairly isolated position within the tribe and that it warrants recognition as the new subtribe Inulantherinae. Detailed phylogenetic relationships and characters supporting these alternative taxonomic hypotheses will be discussed.

## Evaluation of the nomenclatural status of the synonyms of *Enteromius anoplus* (Weber, 1987) (Teleostei, Cyprinidae)

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*Enteromius anoplus*, as currently described, is the most widely distributed freshwater fish in South Africa, with a range extending from the Cape Fold Ecoregion at the southern tip of the continent to the Limpopo River system, which marks the northern-most distribution limit for the species. DNA-based studies have, however, revealed substantial genetic structuring within *E. anoplus*, raising the possibility that this species may harbour undocumented taxonomic diversity. *E. anoplus* was described based on specimens that were collected from the Gouritz River system. Three previously described species, *E. cernuus* from the Olifants-Doring River system, *E. oraniensis* from the Orange River system and *E. karkensis* from the uMngeni River system were put into synonymy with *E. anoplus*, but no adequate justification was provided for these decisions. These names have however been overlooked in all subsequent taxonomic accounts and catalogues of fishes of southern Africa, potentially obscuring biodiversity management and conservation prioritisation. The purpose of the present study is to integrate molecular and morphological data to examine the nomenclatural status of the names currently referred to as synonyms of *E. anoplus*. Results from the molecular and morphological analysis will be presented. The study presents a re-description of *E. anoplus* and revalidation of *E. oraniensis* and *E. karkensis*. Overall, this investigation will contribute to the taxonomic and biogeographic information on small sized minnow species, while eliminating any erroneous conclusions that may come from assuming the species is the same across its entire distribution.

## Contributing towards resolving taxonomic issues on South African Arachnida fauna

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The South African National Survey of Arachnida (SANSA) was launched in 2006 to improve knowledge of the arachnid diversity of the country through collaboration and coordination of arachnological research. The latest stage of this project is the evaluation of South African spiders according to the IUCN Red List categories and criteria. These Red List assessments are in its final stages, with an assessment completed for each of the approximately 2 240 species in 70 families presently known from the country. From all the species assessed, 32% are Data Deficient. This mean that they are either poorly described; not both sexes are known; the description does not include illustrations; or the distribution data is vague. As a result of this, research focusing on addressing some of these issues will be undertaken to publish data for the Data Deficient species. The first paper will focus on the first record of *Euryopis funebris* (Araneae: Theridiidae) from South Africa with re-description of both the sexes. This report extends the known range from the USA and Canada into South Africa.

## Conveyor-driven mass digitisation of herbarium sheets and pinned insects – properties and performance

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Mass-digitisation means imaging entire collections with automatic means. Herbarium sheets are two-dimensional objects and can be imaged with one shot from above, but most other objects in scientific collections are three-dimensional and require more complex solutions. Pinned insects are particularly challenging because of their huge numbers in collections and small size.

Conveyors are now routinely being used for mass-digitisation of herbarium sheets. One conveyor driven system, operated by three to four people, can process up to 5 000 sheets in a working day, which translates to one million sheets/year. The fastest imaging systems for pinned insects reach 1 000 objects/day, operated by just one person, but changing the operator in short two hour shifts. Typically three to six shots are made of the insect from various angles. Three-dimensional photogrammetrical solutions are also being explored.

The presentation covers the technical features of some leading solutions, and the organisational and economic questions that need to be solved in planning a mass-digitisation project.

## The e-Flora of South Africa – restructuring data to comply with Darwin Core standards for inclusion into the World Flora Online

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The e-Flora of South Africa project was initiated in 2013 by the South African National Biodiversity Institute (SANBI) in support of the Global Strategy for Plant Conservation (GSPC, 2011–2020). South Africa's flora consists of ± 21 000 taxa of which more than half are endemic. South Africa will contribute a national Flora towards Target 1 of the GSPC. South Africa's contribution is ± 6% of the world's flora of which ± 3% are endemic and therefore unique. South Africa's electronic Flora is comprised of previously published descriptions.

South Africa's e-Flora data forms part of the Botanical Dataset of Southern Africa (BODATSA), which is currently managed through the Botanical Research and Herbarium Management System (BRAHMS). To date, South Africa's e-Flora data (http://ipt.sanbi.org.za/iptsanbi/resource?r=flora_descriptions) represents 19 539 indigenous taxa, 79 139 descriptions of distribution, morphological, habitat and diagnostic data, and 27 799 bibliographic records. The e-Flora data was recently published online using the Integrated Publishing Toolkit and henceforth harvested by the World Flora Online (WFO) into the portal.

A series of challenges were encountered while manipulating descriptive data from BRAHMS to be ingested by the WFO portal; from taxonomic issues to data quality issues not excluding compliance to data standards.

To contribute to the WFO portal, the taxa in BODATSA has to match with the taxa in the WFO taxonomic backbone. Once there is a match, a unique WFO taxon identifier is assigned to the taxa in BODATSA. This process presented various challenges because the WFO taxonomic backbone and the taxonomic classification system used by South Africa (South African National Plant Checklist) does not fully correlate. The schema used to store taxonomic data also does not agree between BRAHMS and WFO and had to be addressed.

To enable consistency for future, a detailed guideline document was created providing all the steps and actions that should be taken when publishing an e-Flora, managed in BRAHMS, to the WFO portal. The presentation will focus on matching taxonomic classifications between BRAHMS and WFO; dealing with character encoding issues and manipulating data to meet Darwin Core standards.

## Historical and repeat photographs as a source of qualitative and quantitative biodiversity information

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Historical landscape photographs are scientifically valuable evidence of what landscapes looked like in the past and can be a valuable source of biodiversity data in otherwise data-deficient geographic regions. Acquiring repeats of historical photographs on broad geographic scales is possible through rePhotoSA, a citizen science project led by the Plant Conservation Unit and the Fitzpatrick Institute at UCT. Repeat photography has been widely used as a technique with which to monitor changes in vegetation cover and composition in a landscape, sometimes at the population level for individual species. The repeated photograph, once matched to its historical counterpart, can be used to evaluate the qualitative differences in the landscape or species population between time-steps. Quantitative data can be extracted from historical photographs and their repeats using grid cell/crosshair identification and supervised classification using Geographic Information Systems. Photographer perspective and film quality may limit the extent of data mining and analysis, therefore repeat photography is best used in conjunction with field surveys and/or satellite imagery. Despite these limitations, repeat photography provides a novel means of comparing the historical and contemporary condition of a given landscape beyond conventional time frames available for other methods, and remains an under-utilised source of historical biodiversity data.

## Developing fixed-point photography methodologies for assessing post-fire mountain fynbos vegetation succession as a tool for biodiversity management

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Areas of high biodiversity and complex species assemblages are often difficult to manage and to set up meaningful monitoring and evaluations programmes. Mountain Fynbos is such an ecosystem and in the Cape of Good Hope (part of the Table Mountain National Park) plant biodiversity over the last five decades has been in decline. The reasons are difficult to speculate on since large herbivores, altered fire regimes and even climate change could be contributors to this decline, which has been quantified using fixed quadrats and standard cover abundance estimates based on a Braun-Blanquet methodology.

To provide more detailed data with more resolution for identifying ecological processes, Fixed-Point Repeat Photography has been presented as a management solution. However, photography remains a difficult method with which to standardise subjects and has certain operational limitations. These include: weather conditions (poor visibility results in poor images), camera resolution (a low resolution will underestimate the number of small plant, or amount of flowers and fruits/seeds), shadows and image bright spots result in an effective loss of data. Also, photography will always have depth of field problems and perspective distortions. The aim of this study was to develop an effective method of fixed-point photography that overcomes these limitations to assess post-fire Mountain Fynbos succession.

Using the highest resolution Digital Single Lens Reflex Camera (Canon 5Dsr) and a 45 mm tilt and shift lens, three images, each 51 Megapixel in size,were taken to expand the camera's field of view horizontally and vertically since the camera was orientated to produce portrait images. The images were then processed and enhanced using two modern computer programmes (Photoshop and Lightroom) that stitched these images into one and to apply radiometric (colour balance) and geometric corrections (so that images taken at different times can be overlaid).

By repeating this imagery at fixed points using marked out quadrats (3 × 2 m) over different seasons, a large amount of data relating to species richness, structural assemblages and phenological characteristics can be obtained. Such data could include monitoring individual plants, e.g. their growth rates, leaf development, flowering and seed production through to their senescence and death. Use of these enhanced photographic methods for monitoring and evaluation should improve the ability to better manage complex and species rich ecosystems.

A video has been prepared to demonstrate the methods developed in this study:
https://www.youtube.com/watch?v=sdK3U-49Ezg&t=2s

## The utilisation of passive acoustic monitoring as a tool to determine anuran diversity in north-eastern Kwazulu-Natal, South Africa

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Various animal groups have developed the ability to produce species-specific vocal signals, each with unique acoustic patterns. Among these groups, amphibians are one of the most well-known vocalising species. The study of vocal signals allows scientists to monitor anurans based on their acoustic behaviour. The last known survey done on the anuran presence, diversity and geographical distribution in north-eastern KwaZulu-Natal, South Africa was conducted by Minter et al. (2004) using a number of different methods. In an attempt to document the anuran diversity in north-eastern KwaZulu-Natal, the study was conducted by making use of passive acoustic monitoring (PAM) by means of automated recorders. Six localities were identified in Kwazulu-Natal where recorders were arrayed. The recording frequency was set at ten minutes of recording every hour, on the hour between 18h00 to 07h00 for twelve on-going months. In addition to determine the presence of anurans at the sample localities, analysis of the data allowed for the differentiation between both diurnal and seasonal variance in vocal activities. A total of 54% (29/54) of the expected species were recorded at the six localities. Two species, *Leptopelis mossambicus* and *Ptychadena anchietae*, were recorded at all sampled localities. The highest anuran diversity was recorded at St Lucia with 16 species. Due to the El Niño phenomenon, rainfall patterns were not typical for the studied area, which contributed to the low presence of anurans at the different localities. Ultimately the use of PAM to detect the presence and anuran behaviour (seasonal and diurnal), proved to be a practical method for medium- to long-term non-invasive biodiversity estimates at different localities.

## Diversity and composition of ants and spiders along an increasing gradient of invasion by *Chromolaena odorata* at Buffelsdraai Landfill Conservancy, KwaZulu-Natal

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Invasive alien plants are a major threat to South Africa's native biodiversity. In the terrestrial ecosystem, arthropods are the most abundant and diverse group of animals. Ants and spiders are well known bio-indicators of environmental change, as they are highly sensitive and responsive to environmental disturbance. The aim of this study was to determine the response of ant and spider communities to a gradient of invasion by the invasive plant, *Chromolaena odorata* (Asteraceae). The study was conducted at Buffelsdraai Landfill Conservancy, KwaZulu-Natal. Five sites representing an increasing gradient of *C. odorata* were sampled: (1) no invasion, (2) medium, (3) high, (4) cleared and (5) uncleared. In each site, pitfall traps were set for both ants and spiders. Species diversity and composition of ants and spiders were compared. A total of 76 ant and 66 spider species were collected across the sampled site. Ant and spider assemblages differed significantly among sampled sites. Ant species richness was high on the no invasion and highly invaded sites. While spider species richness was high on the cleared and highly invaded sites. The effects on *C. odorata* invasion are more evident on ant and spider richness compared to assemblage structure.

## What structures ant communities along the Udzungwa Mountains: species turnover or richness differences?

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Understanding spatial patterns in biodiversity along elevational gradients and the processes that shape these patterns is a topic of major ecological interest. Despite this long-standing interest in elevational-diversity gradients, little is known about the mechanisms responsible for biodiversity variation along gradients. The aim of this study therefore is to test the processes that structure communities along the Udzungwa Mountains. A standardised pitfall survey was conducted across five elevational transects, each at a distance of 0.1, 1, 20 and 174 km from the first one across three forest types (lowland [300–800 m a.s.l.], sub-montane [800–1 400 m a.s.l.], montane [1 400–1 500 m.s.l.]). In the lowland forest, turnover (environmental conditions) and richness differences (dispersal limitations) did not explain the variation in beta diversity, suggesting that more complex processes might play a significant role. In the sub-montane forest, richness differences explain the variation in beta diversity while in the montane forest turnover explains variation in beta diversity at intermediate distances (10 km) and richness differences at furthest distances (100 km). Across elevations, turnover explains variation in beta diversity at intermediate elevational differences (500 m a.s.l.) and richness differences at high elevational differences. Findings in the current study have a potential to inform conservation planning in the Udzungwa Mountains.

## Trade-offs: mechanisms that facilitate co-existence in the grassland ant communities

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Previous studies have reported up to 30 ant species co-existing in a 1 $m^2$ of leaf litter in eastern Brazil while in the semi-arid of northern Victoria in Australia, 80 species in 0.25 hectares were reported to be co-existing. Trade-offs have been proposed as mechanisms that facilitate such co-existence. The aim of this study was to determine whether fire influences trade-offs in the grassland ant communities. The study was conducted at the University of KwaZulu-Natal grassland (Pietermaritzburg). Two habitats (burnt and unburnt) were selected, each with five replicates, 50 m apart. A 3 × 4 grid (12 baits) of laminated index cards with cat food was laid out in each replicate. Surface temperature was recorded for all bait stations using an infrared thermometer. Ant activities were observed every 15 minutes for 3 hours and recorded all interactions between species. Findings showed no significant relationships between dominance–temperature tolerance, time (min.) to discover baits and dominance in the burnt and unburnt plots. There was a significant relationship between percentage number of baits discovered and dominance in the burnt habitat. There was a weak relationship between dominance–temperature and dominance–discovery across the two habitat types. However, there was evidence of temperature-based niche partitioning in both habitats.

## Does soil acidity play a role in determining ant species diversity and composition in a mistbelt grassland of KwaZulu-Natal?

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Nutrient addition is an important component of land-use change globally. Nitrogen fertiliser is the main nutrient affecting soil pH, which can either make soils become more acidic or more alkaline depending on the form of nitrogen used. To determine the effect of soil acidity on ant community response, we used 72 plots (9 m × 2.7 m) fertilised for more than 50 years with two forms of nitrogen (N as limestone ammonium nitrate [LAN] or ammonium sulphate at three levels: control, high and low). We hypothesised that high soil acidity reduces ant species due to its indirect effects on vegetation, which affects soil temperature. Standardised pitfall traps were used to sample ants. A total of 2 199 individual ants representing 36 species, 17 genera and 4 subfamilies were collected. Ammonium sulphate (high) and a control plots had the same number of ant species (24 representing 67% of total species). Species diversity was relatively high in the control followed by LAN (high) and ammonium sulphate (high), while ammonium sulphate (low) and LAN (low) were the least diverse treatments. The findings of this study suggests that soil acidity promotes richness of cryptic ants, which play an important role in soil nutrient cycling.

## Are arthropod communities changing with changing land-use patterns in communal areas?

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Human activities significantly alter biodiversity and consequently impede their ability to provide services crucial for ecosystem function. Arthropods rapidly respond to environmental change and can therefore provide information for conservation in line with land-use change. This study aims to understand the dynamics of arthropod communities in response to land-use change in the communal areas of KwaZulu-Natal. It particularly considers the extent to which habitat transformations are resulting in a shift in taxonomic and functional diversity of the ecosystems and their service provisions. Nine communal areas were sampled, each replicated four times. Pitfall traps set in a 5 × 2 grid used to collect arthropod data in croplands, rangelands and settlement areas. A 1 $m^2$ quadrant placed on top of each pitfall trap was used to collect vegetation data and soil was collected from each grid. Traps were left open for five days and collected to the laboratory for determination of taxonomic and functional diversity of ants, spiders and beetles. Preliminary results indicate the lowest arthropod abundance in settled areas, increasing in the croplands and taking a peak in the rangelands. Determining how various function guilds respond to land-use will assist in determining the role of arthropod communities and their conservation in these communal areas.

## DNA barcoding of freshwater fishes from southern Africa: assembling a reference library for topotypes to expedite species inventory

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Over the last century, freshwater fishes in southern Africa have become increasingly imperilled by multiple impacts. Poor understanding of biodiversity has been identified by the Convention on Biological Diversity (CBD) as a major impediment to effective conservation planning and management of threatened taxa. Here we present a comprehensive DNA barcode reference library for topotypes of species (both valid and synonyms) of freshwater fishes that were described from southern Africa. We provide case studies from the Cape Fold (CFE) and the Eastern Zimbabwe Highlands (EZH) freshwater ecoregions where integration of topogenetypes has facilitated rapid assignment of newly collected specimens to known species, revealed taxonomic conflicts within several currently recognised species, and allowed determination of the status of currently synonymised species.

Taxonomic revision of the genus *Pseudobarbus* in the CFE resulted in the description of three new species, *P. skeltoni*, *P. verloreni*, *P. swartzi* and resurrection of *P. senticeps*. At least 12 candidate species were identified within *Galaxias zebratus*, another CFE endemic. An ongoing revision of *Enteromius anoplus* will result in the resurrection of *E. karkensis*, *E. oraniensis* and *E. cernuus* as well as description of at least one new species.

Stream fishes of the Eastern Zimbabwe Highlands freshwater ecoregion are among the least studied vertebrates in southern Africa, despite the potential for harbouring cryptic diversity. We examined mitochondrial cytochrome oxidase subunit I (COI) sequence divergence in 153 specimens of stream fishes belonging to four genera and three families, [(*Amphilius* and *Zaireichthys* (Amphiliidae); *Chiloglanis* (Mochokidae); and *Hippopotamyrus* (Mormyridae)], in the Eastern Zimbabwe Highlands (EZH) freshwater ecoregion to explore the extent to which the current taxonomy conceals the ichthyofaunal diversity in the region. The General Mixed Yule Coalescent (GMYC) species delineation method identified 14 clusters within five currently recognised 'species' from the EZH ecoregion. Only one of these clusters represents a named species, while 13 of them represent candidate or undescribed species.

These results indicate that effective conservation of southern Africa's unique ichthyofauna is limited by the incomplete knowledge of taxonomic diversity and inaccurate mapping of species distribution ranges.

## The branchiopod crustaceans of ephemeral wetlands in the Northern Cape

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The most pronounced occurrence of ephemeral wetlands in South Africa is found in the Northern Cape, an arid region characterised by low and sporadic summer rainfall (MAP < 250 mm) and high evaporation (> 2 000 mm per year). These systems collectively cover an area of over 5 000 km$^2$ and due to their natural hydrological functioning they are subjected to complete desiccation during dry periods, which can last for decades. Consequently, they are often regarded as degraded or lifeless systems and have received little attention in terms of research. By contrast, when it rains enough for these waterbodies to hold water, dormant aquatic organisms respond and wetlands are resurrected to produce stepping-stone biodiversity corridors in an arid landscape. Branchiopod crustaceans are known to be the flagship species of similar arid waterbodies globally, but yet have never been studied in the Northern Cape. This restricts the effective management and conservation of these wetlands. The current project aimed to collect extensive information regarding the distribution of Branchiopod species in the Northern Cape ephemeral wetlands and was enabled through a FBIP Small Grant. Ground breaking distribution records and species information obtained from 109 study sites across the province, are presented.

## The distribution of the biodiversity-threatening alien invasive commensal species of *Rattus* and the environmental and socioeconomic factors that may influence their presence in urban Gauteng Province, South Africa

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The distribution of organisms can best be explained by factors that can influence their presence. By identifying such factors from biodiversity-threatening alien invasive species' current or native ranges, we can predict possible areas of future invasions and potentially manage current invasions. This study aimed to determine the distribution of the alien invasive commensal species of *Rattus* in urban landscapes and to identify the environmental and socioeconomic factors that may influence their distribution in Gauteng Province, South Africa. Predictive distribution maps of the species were obtained using Species Distribution Modelling (SDM) with Maxent and Generalized Linear Models (GLMs). These methods used locality data obtained from the literature and a selection of environmental and socioeconomic variables. In addition, survey questionnaires directed at pest control companies within the province, and a door-to-door survey of households in the City of Johannesburg were conducted to reveal potential socioeconomic factors. The SDM showed that Maxent performed better at predicting the distribution of species of *Rattus* in Gauteng Province than the GLM. The environmental variable that contributed the most to the model was the Human Footprint Index (HFI) emphasising the commensal nature of the species and that the presence of rodents in residential areas is potentially influenced by the accumulation of waste and the condition of the housing infrastructure. Pest control companies use a range of rodent control methods, which include bait stations and rodenticides, and revealed that poor sanitation and poor-quality housing were related to high rodent infestation at their sites of rodent eradication initiatives. Collaborative initiatives that include a range of stakeholders ranging from ecologists, members of the community, local government officials, municipal officials, and health, agricultural and nature conservation authorities may assist in reducing infestations through well-structured community engagement programmes.

## Alien plant survey of the Haenertsburg village, Limpopo Province, South Africa

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It is generally accepted that urbanisation is changing the composition of species mostly in urban areas and the surrounding areas. The recently published South African National Status report on biological invasion has shown that there is dearth of knowledge regarding the status of Invasive Alien Species (IAS) in many parts of the country. Regrettably, little is known about the status of alien plant species in critically threatened vegetation, Woodbush Granite Grassland. I investigated the status of alien plant species in WGG. A total of 136 species were identified, belonging to 46 botanical families. The predominant families were Asteraceae, Fabaceae and Rosaceae. As far as plant invasions are concerned, these findings also point at the fact that the Woodbush Granite Grassland is facing a new threat, following habitat destruction in the area, as it may decrease the remaining Woodbush Granite Grassland size. Included in our list are alien species that need urgent eradication.

## Biodiversity co-benefits through reforestation for carbon sequestration

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There is a growing interest in the potential of reforestation to support the recovery of biodiversity. Studies examining how biodiversity responds following restoration may provide guidelines towards a successful recovery process. This study was conducted in Buffelsdraai Landfill Conservancy, a landscape historically used for sugarcane production that has been reclaimed for restoration. There is conflict that needs to be explored between reforestation for carbon sequestration and/or for biodiversity conservation. Using a standardised pitfall survey, we assessed how ants responded to reforested habitats of different ages, relative to natural grassland, forest and different sugarcane stands, as well as to determine the environmental variables underlying differences in ant diversity and composition along the reforestation gradient. Species richness significantly decreased with increasing bare-ground cover. Ant assemblages differed significantly across all sites, with forests having the most distinct assemblages. The restoration sites were transitioning from sugarcane plantation, and were drawing most of their colonisation from grasslands. Our results showed that biodiversity benefits can be increased more if the restoration sites are kept as open woodlands with a grass layer in between them. Importantly, we demonstrated the importance of grasslands as a source of diversity to colonise the restored habitats.

## Diatoms associated with two South African kelp species: *Ecklonia maxima* and *Laminaria pallida*

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Kelp forests are believed to host a large biomass of epiphytic fauna and flora, including diatoms, which constitute the base of aquatic food webs and play an important role in the transfer of energy to higher trophic levels. Epiphytic diatom assemblages associated with common South African kelps, *Ecklonia maxima* and *Laminaria pallida*, were investigated in this study. Primary blades of adult and juvenile thalli of both kelp species were sampled in July 2017 and analysed using a scanning electron microscope (SEM). Our results showed that both kelp species hosted relatively low diatom densities (ranging from 7 [SD 5] cells $mm^{-2}$ on adult specimens of *L. pallida* to 43 [SD 66] cells $mm^{-2}$ on juvenile blades of *E. maxima*), with *Amphora* and *Gomphoseptatum* reaching the highest absolute abundances. Although non-metric multidimensional scaling (nMDS) graphs showed overlapping and largely scattered sample sets, a significant relationship between the diatom communities and species and age of the host macro-alga was detected by two-way PERMANOVA. In general, more abundant and diverse diatom communities were observed on juvenile thalli than on adult thalli, with species belonging to *Navicula* and *Rhoicosphenia* contributing significantly to the observed dissimilarity. Due to a significant interaction between species and age effects, however, the overall ability of kelp species, their age, and their interaction to explain the variation in diatom community structure was limited. We suggest that the low epiphytic diatom densities were directly related to the observed sloughing of the epithelial cells by both kelp species. We further speculate that on such unstable substrata some diatom taxa might adapt to endophytic life to avoid antifouling mechanisms developed by their hosts.

## Assessing mammal diversity and the effectiveness of different methods for monitoring mammal diversity in diverse land tenures in a South African arid ecosystem.

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Management and conservation actions are only as effective as our ability to monitor and assess diversity measures and trends. We therefore need to assess which methods are efficient and effective at assessing mammal diversity. We assessed nine different methods: camera traps, small mammal traps, track plates, mist nets for bats, acoustic surveys, spotlight surveys, and block transects recording individual animals, scat and tracks. We also conducted interviews to assess local knowledge, which we will verify with the other methods. We surveyed at Erin game-hunting farm and in the livestock farms in the Khomani San Community Protected Area. The combination of field survey methods detected 26 species in Erin and 27 in the livestock area. Species-accumulation curves presented differences in the amount of time needed to effectively survey the area between the land-tenures, the curve asymptotes around Day 5 in Erin, but with the livestock areas only on Day 8. Community member interviews identified a total of 37 species in Erin and 33 species in the livestock area. The main difference between interviews and what we detected is likely due to some trap-shy rodent species. Our preliminary results suggest that there is no major difference in mammal diversity between the livestock and game-hunting areas. Block transects looking for tracks were the most effective method in both areas, as it detected the most species. However, more effort is needed to effectively survey mammal diversity in the livestock area.

## Taxonomic bias in foundational biodiversity data, research interests, extinction risk, and cultural salience: A South African herpetofaunal perspective

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Biased focus on a few, mostly charismatic species hampers efficient decision making in conservation. Herpetofauna are considered less charismatic than most taxa, especially in South Africa where they are subject to many cultural taboos. This lack of charisma may place herpetofauna in a precarious conservation position. We investigate taxonomic bias within biological sciences to gain an understanding of the extent to which South African herpetofauna receive attention in three sources of bias that are important to conservation planning; foundational biodiversity data, research interest and cultural salience. These sources of taxonomic bias are contrasted with conservation status of taxa to make inferences about the correlation between level of threat and amount of attention received.

## Roads and users as a threat to wildlife conservation: modeling amphibian roadkill in Vhembe Biosphere Reserve (Soutpansberg Conservancy), South Africa

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Increasing threats of transportation infrastructures to wildlife makes it imperative to monitor road impacts on wildlife. Despite evidences proving that transportation networks are associated with a pool of threats degrading the integrity of wildlife, very little has been done in Soutpansberg Conservancy in Vhembe Biosphere Reserve. Many population of amphibians suffer violent mortalities and are declining at a rapid rate, resulting to a great conservation concern. Their ecology and size make them easily smashed by vehicles, especially during breeding seasons. However, it is with great pity that the ecological impacts that amphibians unpleasantly suffer from roads are poorly discussed in many African studies. With the proposed road development plans around this region, threats to wildlife are predicted to accelerate enormously. This study aims to undertake an assessment of vertebrates' roadkill on a combined 112 km line transect along three regional road networks bisecting the Soutpansberg Conservancy. This project monitors wildlife roadkill, with focus on amphibians, for the upcoming 2018/2020 hot/dry and hot/wet ecological seasons. This will assist in developing a roadkill database of Soutpansberg Conservancy, and identify habitat characteristics that are associated with wildlife roadkill.

## Creating a model for the prediction of roadkill Kruger National Park, South Africa

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Roads not only create barriers for animals by preventing the free movement of individuals between populations, but also cause mortalities through collisions with vehicles (i.e. roadkill). In South Africa, most of our understanding of roadkill events stems mainly from research on national and regional roads, with very little known about the impacts of roads in protected areas. Despite *ad hoc* roadkill reports in protected areas by members of the public on social media, there have been little systematic roadkill surveys undertaken in South African protected areas and, road signage aside, no effective mitigation measures have been applied except the traffic officials, who are unable to monitor all roads simultaneously. Our study will form part of a five-year project to undertake an assessment of roadkill in protected areas and assess mitigation measures to reduce it. The present two-year project will record temporal and spatial roadkill in one section of the Kruger National Park, on both paved and unpaved roads. Factors such as surrounding habitat, proximity of a water source and traffic volumes and speeds will be recorded. Using these data we will identify the predictors of where roadkill is most likely to occur, which will then be used to develop a 'Roadkill Risk Map'. The procedure can then be tested in other protected areas and used as a future, cost-and-time-effect model for roadkill reductions.

## Dispersal of invasive *Lantana camara* by native bird species in KwaZulu-Natal, South Africa

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Alien invasive plant species are a major problem globally, threatening ecosystem functioning and biodiversity. Their spread is facilitated by native bird species through mutualistic relationships. Studies of seed dispersal of alien invasive plants are important for effective management. In this study, the role of native bird species in the dispersal of the highly invasive shrub, *Lantana camara*, was investigated through observations. A total of 56 bird species were observed visiting *L. camara* with only 28 species consuming the fruit. Visitation frequencies were significantly higher for small and medium-sized frugivorous species. The dark-capped bulbul *Pycnonotus tricolor* was the most observed frugivorous bird species visiting and was likely the main disperser of *L. camara*. Interestingly, two non-frugivorous birds, the white-bellied sunbird (*Cinnyris talatala*) and the white-browed scrub robin (*Cercotrichas leucophrys*) showed relatively high visitation frequencies. Of the 28 species that ingested fruit, potential dispersal distances ranged from 9 to 45 km. Short dispersal distances were more common than long dispersal distances limited by relatively rare frugivores. Level of frugivory and body size were the main traits that influenced the ability of bird species to be effective dispersers. These results emphasise the importance of bird–plant mutualisms for fleshy-fruited invasive plant success.

## Dune fynbos–thicket vegetation of the Cape coast: proposing an updated and unified treatment

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Coastal dune vegetation in the Cape Floristic Region (CFR) is poorly defined and currently lacks consistent treatment as it is classified across different biomes and existing types incorporate multiple edaphic zones. We propose that the fynbos–thicket mosaics (also known as strandveld) typical of young (Holocene-age) coastal dunes of the southern and south-eastern Cape coast are a unique vegetation assemblage based on floristics, ecology and evolutionary history. This vegetation assemblage is in dire need of an updated and unified classification, which we aim to complete and submit for incorporation into the National Vegetation Map of South Africa (VegMap). Here, we present some preliminary findings and expound on future work. Our updated classification, based on clustering and ordination methods, will incorporate georeferenced vegetation plot data (plant species cover abundance) available in the literature and in existing databases (e.g. National Vegetation Database). After compiling existing data, we identified under-sampled areas along the coast and, in spring 2018, collected new plot data from six sites; additional data will be collected in spring 2019. Supplementary to the plot data, we are compiling flora checklists for selected sites. Ultimately, we aim to compile a checklist for the entire CFR coastal dune flora; this will incorporate existing floras, data collected during fieldwork and iNaturalist records. Species endemism (local and regional scale) and turnover is largely associated with the fynbos component (Cape clades) of the vegetation; the thicket component (tropical clades) harbours far fewer regional endemics and species turnover between regions is less pronounced in this element. As a result, classification of CFR dune vegetation at the type-level is largely driven by the fynbos component. However, several thicket species are widespread dune endemics, and this component is important to identify dune fynbos–thicket mosaics as a unified vegetation assemblage. CFR coastal dune vegetation — a naturally rare habitat rich in endemic species — is highly threatened by ongoing alien plant invasion and coastal development. An updated and integrated classification of this vegetation assemblage will greatly aid conservation and management planning to help safeguard this unique part of our natural heritage.

## The influence of flow and temperature on mayfly (Ephemeroptera, Insecta) community structures in the Luvuvhu River catchment

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Freshwater ecosystems are threatened by changes in stream flow patterns and water temperature. The impact of these drivers on instream assemblages have rarely been explored in the Afrotropical Region. Here we investigate the response of mayfly diversity to stream flow and water temperature in a strategic water resource located in the arid northeastern corner of South Africa. Mayfly larvae were sampled monthly in rheophylic biotopes, across 23 sites over a one-year period. A total of 19 species, in 16 genera and six families were recorded. The relationship between these drivers and diversity was modelled using generalised linear mixed models (GLMMs) and a model-based multivariate approach. Threshold Indicator Taxa Analysis (TITAN), was used to model the response of mayfly species to temperature and flow gradients and identify thresholds of change. The best model for abundance included a positive relation with TDS and pH and declined with temperature. Richness had similar relationships but did not include TDS in the best model. Temperature had the coefficient of determination for both conditional and marginal models and the only predictor included in the both conditional and marginal models. TITAN identified six species as reliable indicators of thermal change, five of which declined in response to the increasing levels of temperature with threshold temperature at 19°C. Only one species increased in response to warmer temperatures. This study highlights the importance of temperature in structuring mayfly assemblages and with significant implications for these biota under predicted climate and land use change scenarios.

## Highlights from the Global Environmental Change Programme of the Durban Research Action Partnership

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The Durban Research Action Partnership (D'RAP) is a research partnership between the University of KwaZulu-Natal and eThekwini Municipality, Durban. Through D'RAP, collaborative, focused research is conducted within the eThekwini Municipal area across a range of disciplines. These research programmes aim to generate knowledge and learning to address gaps between scientific research, policy development and management in a local government context. We detail highlights of the Global Environmental Change (GEC): Durban Metropolitan Open Space System (DMOSS) Research Programme (2015–2018). This phase of research has produced valuable baseline data, such as bird and mammal species diversity in conserved forest patches, base nitrogen levels, suggestions for managing human–wildlife conflicts, and wildlife biodiversity assessment on eco-estates. Two potential bio-indicators were identified from the research for use in monitoring of the unique KwaZulu-Natal Sandstone Sourveld habitat that occurs in the region. These outputs have highlighted the importance of conserving natural DMOSS areas as a means to conserve biodiversity. The programme also had a unique feature were an embedded researcher was placed within the Municipality. This climate change post-doctoral student analysed how climate information could better be integrated into biodiversity planning. Outputs include the development of a long-term environmental change monitoring programme.

## Taxonomy and diversification of the southern African *Pteronia* L. (Asteraceae)

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*Pteronia* is a large, often aromatic, shrubby genus comprising ± 76 species, most of which favour arid habitats within the Greater Cape Floristic Region. The genus was last revised by Hutchinson and Phillips in 1917, who recognised four sections based exclusively on leaf indumentum. However, this classification is considered largely artificial and in need of reassessment. A systematic study was carried out to investigate the phylogenetic relationships of *Pteronia*, estimate the divergence times and infer biogeographic patterns of the genus. Phylogenetic analyses of the genus were based on two nuclear (internal and external transcribed spacer: ITS, ETS) and one plastid (*trnL-F*) DNA sequence data. Phylogenetic analyses revealed that *Pteronia* is monophyletic with four main clades recovered and that the current infrageneric classification is unnatural. The divergence time of *Pteronia* was estimated to 7.8 Ma (95% HPD: 3.9–13.1 Ma), in the late Miocene period. The ancestral distribution of the genus was established to be most likely of Fynbos Biome origin. A comprehensive taxonomic revision of *Pteronia* was also completed in which five new species were described. The current study has generated new insights into species circumscriptions, phylogenetic relationships, evolution and biogeographic history of the genus *Pteronia*.

## *Cladosporium* species in the natural habitat: a source of contamination for indoor environments

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Indoor fungal communities can be incredibly diverse and can include members acting as pathogens and allergens, which is undesirable for the health and well-being of its occupants. It therefore became a global health concern. *Cladosporium* are one of the most common indoor molds and generally produce high numbers of spores. The genus is one of the larger fungal genera and comprise more than 245 accepted species. Only a few species are linked as etiologic agents of human diseases or allergies. This study aims to investigate the prevalence and diversity of *Cladosporium* from the indoor environment. Air samples were collected in Western Cape houses into 2% MEA from where isolations were made. Strains were identified based on a polyphasic approach based on DNA sequence data and morphological characters. In this study, we present insight into the general diversity of species from indoor environments, with preliminary results showing that South Africa contain unique species, similar to a previous survey. It is, however, unclear whether these species are able to trigger allergic reactions in humans. However, the screening and identification of allergens is part of this work to be covered in the future.

## Towards a data management solution for marine biodiversity data derived from imagery

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Data obtained from biodiversity surveys represent irreplaceable information about our planet and should be preserved for reuse to ultimately address questions at the broader scales, or not originally perceived, that will have societal and scientific relevance. However, biological environmental research is a data intensive science that includes large quantities of heterogeneous data, but often lacks widely applicable standards. Consequently, management of biodiversity data, especially those derived from more formal monitoring efforts, are challenging. We developed a data management solution to streamline data curation of abundance and length records of reef fish and macrobenthos collected by remote underwater imagery methods. Using the web-enabled Specify software, we first compared the fields needed by such survey types to the fields already available in Specify. A process of semi-automated data carpentry was then developed to manipulate the data into the format required to migrate the data to the Specify database using the Specify Workbench application. From here data can be exported as Darwin Core compliant records to enable easy publication of the data to the Global Biodiversity Information Facility Data Portal.

## Nutritional composition and diversity of consumed insects in Africa: a systematic review

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Insects are consumed as food in different parts of the world and their consumption is not a new phenomenon as it can be traced back since prehistory before people had tools for farming and hunting. The aim of this study was to determine diversity and nutrient content of edible insects in Africa. To explore the diversity and nutritional status of edible insects in Africa we reviewed 96 existing peer reviewed literature using the Thomson Reuters' Web of Science database. A list of 212 edible insect species from six orders were compiled; of these 41% were Lepidoptera, 23% were Orthoptera, 15% were Coleoptera, 11% were Isoptera, 4% were Hemiptera and Hymenoptera. These insects are rich in protein, carbohydrates and fibre. The highest protein content of 79.6% was reported in *Gonimbrasia richelmanni* and in *Imbrasia macrothyris.* Fibre was reported to be higher in *Aphodius rufipes* (28.12%) and *Gonanisa miai* (16.2%). The highest amount of carbohydrate content was recorded in pallid emperor moth and rhinoceros beetle with carbohydrate content of 54.2 and 51.6% respectively. Considering the excellent source of nutrition and socio-economic benefits found in edible insects, edible insects are a potential solution to food security problems in developing countries.

## Red Listing South African spiders: the end-game of the South African National Survey of Arachnida

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The South African National Survey of Arachnida (SANSA) was launched in 2006 to improve knowledge of the arachnid diversity of the country through collaboration and coordination of arachnological research. During the last two decades, considerable effort has been made to collect, identify, database and create products on the biodiversity of the country's arachnids, including the *First Atlas of the Spiders of South Africa (Arachnida: Araneae)*. This book included detailed information on the region's spider species such as occurrence, biome records and conservation status of 2003 species known from South Africa until 2010. Since then, considerable effort has gone into identifying and describing species in preparation for the Red Listing of South African spiders, which also includes the species from Lesotho and Swaziland. This process is in its final stages, with an assessment being made for each of the approximately 2 240 species in 70 families now known from the country. Assessment information includes the common name, taxonomic status (such as sexes known, whether recently re-described, illustrated or not), national status and rationale for this classification, distribution globally and in South Africa, habitat, threats, assessment comments, and a list of georeferenced localities from the three countries covered (Country, Province, Locality, Sub-locality, decimal degree co-ordinates), as well as all relevant literature. As per the IUCN Red Listing categories and criteria, a large proportion of the species (62.5%) are of Least Concern having a wide distribution. For 31.6% of the species the data is deficient; 49 species are Rare (2.2%); 15 species are Critically Rare (0.7%); 22 species are Endangered (1%); 10 species are Near Threatened (0.4%) and 36 species are Vulnerable (1.6%). The Red List data will soon be available on the SANBI online database portals.

## Untapped bacterial diversity and metabolic potential within South African scalding springs

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The bacterial diversity in Hot Springs (Blikhuis, Brandvlei, Blossom Well Field, Calitzdorp, Caledon BH1, Caledon BH2 and Montang) located in the Northern and Western Cape provinces of South Africa were studied to expand our knowledge of bacterial life under specific extreme conditions. The temperatures in these springs ranges between 27 and 56°C. The pH was slightly acidic (6.00–6.61) with the exception of Blossom Well Field with a pH of 7.99. The metagenomic Illumina MiSeq analysis showed a total operational taxonomic units of 44 213, with a predominance of the phylum Proteobacteria (80%) followed by Firmicutes (4.4%), Nitrospirae (3.4%) and Actinobacetria (3.1%) on average. The ecological indexes indicate a large bacterial diversity in all the hot springs. The high concentration of $CH_4$ (11g/L) and $CO_2$ (451 g/L) gases in most of these hot springs suggested that the Proteobacteria phylum could be involved in the reduction of $CO_2$ to $CH_4$. The presence of substantial concentrations of sulphate, sulphide, nitrate and nitrate suggested that the bacteria population could be involved in the sulphur and nitrogen biogeochemical cycle. A principal coordinate analysis plot representing microbial diversity and abundance in the different sites indicated that there were significant similarities between different sites notably in Blikhuis and Blossom Wells communities and dissimilarities were also observed in the among other sites.

## Anthropogenic impacts on arthropod diversity on an arid elevational gradient

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Mountains are considered biodiversity hotspots because they can have variable environmental conditions within a limited spatial configuration. Hence ecologists have been using mountainous regions to study biodiversity patterns. However, some of these mountains are under threat from anthropogenic factors such land use changes and climate change. Land use change particularly has been shown to greatly influence biodiversity; therefore, the current study aims to investigate how the recent anthropogenic activities (change in land-use) across the Soutpansberg have affected the epigeal arthropod diversity. Another aim is to determine whether the interaction between land-use change and elevation affects ant and spider diversity, and to understand the co-existence of the dominant taxa across the elevational gradient. Ants and spiders will be used as the model taxa as they are excellent biological indicators owing to their higher diversity, sensitivity to environmental change and the various ecosystem services they perform. Ants and spiders will be sampled at the sites currently undergoing rapid land use changes and those that have not been disturbed along the Western Soutpansberg. A total of 15 sites will be sampled ranging from 800 m to 1 700 m on a southern and northern aspect across the mountain. Each site will be replicated four times with 300 m between replicates. Each replicate will have 10 pitfall traps in a $2 \times 5$ grid, which are 10 m apart. The pitfall traps will be left open for five days during September 2019 (dry season) and January 2020 (wet season). Using R programming, functional and taxonomic diversity will be analysed using PCA (principal component analysis) and the response of functional diversity to environmental variables will be modelled using Linear Mixed-Effects Models. The knowledge gained from this study should give an indication of how biodiversity is affected by land use changes in mountainous regions.

## *Trichoderma* as a functional fungal group in the rhizosphere of maize and wheat under conventional and conservation agricultural practices

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*Trichoderma* spp. are widely distributed in the environment and can be found in soil, on plants and sometimes in old decaying buildings. The majority of species in the genus *Trichoderma* plays an important role in the industrial sector as they serve as producers of economically important enzymes. Moreover, their application has also been extensively exploited in the agricultural sector as it is used as biological agents and biological fertilisers. However, in some cases *Trichoderma* spp. have been reported to cause diseases in mushrooms and they are also opportunistic pathogens in immunocompromised individuals. Thus, this project aims to assess and identify naturally occurring *Trichoderma* spp. that are capable of enhancing the growth of both wheat and maize. In addition, the effect of farming practices i.e. conventional and conservation agriculture on the presence of this group in the rhizosphere of maize and wheat, will be investigated. Ultimately, we would like to identify potential biological fertilisers, in order to reduce the use of chemical fertilisers, or at least understand how farming practices can increase their presence in soil. Furthermore, this project will contribute to the knowledge of native *Trichoderma* spp in South Africa.

## Diversity of culturable oomycetes in the Cape Point Nature Reserve

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Oomycetes are fungus-like organisms common in soil and aquatic environments. Several oomycetes are known for their devastating impact on food security or naturally occurring flora and fauna; however, many oomycetes are saprophytes that may be important in food webs by decomposing debris or serving as food for other organisms. Aside from some records of *Phytophthora*, few records of oomycetes in Western Cape natural soils exist, and species identities have often not been provided. The aim of this project is to assess the diversity of culturable soilborne oomycetes in the Cape Point Nature Reserve. Five soil samples were taken from each of fifteen locations representing coastal, inland, and wetland sites, mountain peaks, as well as tourist sites with increased human activity (75 samples in total). Oomycete isolates were recovered from soil using a soil baiting approach. A total of 1 414 putative oomycete isolates were purified and grouped according to morphological characteristics. A total of 1 086 isolates representative of all morphological groups per sample, bait and medium were selected for species-level identification using internal transcribed spacer restriction fragment length profiling (ITS-RFLP), ITS sequencing and phylogenetic analyses of representative isolates. To date, all isolates from 44 of the 75 samples (n=672) have been identified to species level. The majority of these belong to the genus *Pythium* (n=536), followed by *Phytopythium* (n=47), *Phytophthora* (n=19), *Saprolegnia* (n=6) and *Pythiogeton* (n=3). Sixty-two isolates were found not to be oomycetes (mainly *Mortierella* spp.). Altogether 49 oomycete species were identified, of which 26 have not previously been described. The most widely distributed species were *Pythium* cluster B2a (*P. coloratum*/*diclinum*/*dissotocum*/*lutarium*/*marinum*) (7 sites, 14 samples), *Pythium cederbergense* (6 sites, 14 samples), and *Pythium rostratifingens* (6 sites, 8 samples). Samples from coastal and wetland sites and sites with increased tourist activity yielded more species per sample (av. 2.7–3.0) than samples from inland and mountain sites (av. 1.0). Nine of the 23 described species had not previously been reported from South Africa. Tourist sites had more of these species (n=5) than other sites (n ≤ 3), suggesting that tourists might be introducing foreign oomycetes into the reserve.

## Assessment of population demographics, resprouting and herbivory among *Protea curvata* populations

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*Protea curvata* is a vulnerable species endemic to Mpumalanga. Six populations were identified. The demographics and presence of damage on resprouting shoots were assessed for each population. For both tree height and biomass, five populations did not fit the J-curve expected in a recruiting population. Instead, some biomass classes were often absent. Juvenile trees were rare, except in three populations. The two most distinct populations (in terms of population demographics) were on contrastingly managed sites. The population which experienced infrequent, intense fires and a recent hailstorm had the lowest flowering. It also lacked juvenile trees and had a disproportionately high number of older trees. The frequently burnt site had a high number of juvenile *P. curvata* trees and flowered relatively well. This is attributed to the impact of woody species density and grass to woody biomass ratio on seedling establishment. Seedling establishment is further limited by the lack of canopy seed-storage. Fire and bite marks made up the largest proportion of damage on re-sprouting shoots and bite marks were the most common type of re-sprout damage. Therefore, browsers have a considerable impact on *P. curvata* shoots. Overall, efforts to encourage flowering and seedling establishment in the six populations are crucial for improving the status of this vulnerable species.

## Anuran diversity and micro habitat utilisation at Wakefield Farm in the Nottingham Midlands, KwaZulu-Natal

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Global biodiversity is continuously declining and in particular amphibians. The Amphibia is now officially recognised as the most threatened vertebrate class. This forecasts a major impact on ecosystem services, since amphibians play a key ecological role as both prey and predator, and because they are closely linked to the state of health of their specific micro-habitats. Passive acoustic monitoring is a method of conducting biological surveys of frogs. Automated song recorders (song meters) are placed in the field to record the sounds of amphibians. The recorded data is used to determine a wide range of information such as, amphibian diversity at a site, call activity, call intensity, animal activity patterns linked with climatological conditions, and many more. Passive acoustic monitoring is a non-invasive surveying method that can determine the presence of cryptic species, which are otherwise extremely difficult to detect. Micro-habitats such as ponds or river beds are smaller divisions of macro-habitats such as grassland or a forest and are important in determinants of precisely where specific frogs occur and what environmental factors determine their selection of sites. Because of the important ecological role of amphibians, information about their selection and utilisation of micro habitats can contribute significantly to conservation management practices on a local and landscape scale. Wakefield is situated in the Nottingham Midlands region of KwaZulu-Natal. It comprises mainly grasslands with substantial areas of indigenous forest. The expectation of useful results from amphibian research on Wakefield is enhanced by the fact that a desktop study indicates that it is rich in frog species. *Leptopelis xenodactylus* is a poorly known Endangered species and if it is present on Wakefield it will provide an excellent opportunity to study this rare burrowing tree frog. It is thus of the utmost importance that we understand our amphibian biodiversity and their specific habitat requirements to optimally protect them in their environment. Together, these two aspects can provide a platform for amphibian conservation and management.

## The impact of medicinal plants used for treating asthma in Nkandla, Kwazulu-Natal, South Africa

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Asthma is a common disabling respiratory disease that affects humans. This study represents the first ethnobotanical survey on plants that are used to treat asthma by the tribal people of Nkandla area. The key purpose of the study was to identify medicinal plants used to treat asthma, as well as to note harvesting techniques used by the indigenous groups.

An ethnobotanical survey was conducted among Nkandla residents to collect information. Data was collected through the use of questionnaires. During the survey, 17 species belonging to 16 genera of 11 flowering plant families were said to have medicinal use. The best represented families were Asteraceae (seven species) and other 12 families with one species each. In terms of the life form, the highest number (9) of species used were herbs followed by trees (5), climbers (1), succulents (1) and shrubs (1). The most used plant parts in herbal preparation were leaves (39%), bark (18%), roots (11%) and fruits (7%), Bulb juices, twigs and stems (4%) and tubers, rhizomes and seeds (3%).The most cited medicinal species in survey are *Mormodica charantia, Aloe ferox, Cannabis sativa* and *Hypoxis hemerocallidea*. This study showed evidence that Nkandla locals prefer traditional medicine to cure asthma due to low cost. Sustainable harvesting of these plants is crucial, thus there is a need to raise an awareness about the importance of these plants. These results could be a starting point for laboratory screenings.

## Characterisation and morphological classification of an unidentified plant found in Limpopo province, South Africa

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Plants that are not known to science and have not yet been identified are at risk of extinction due to land development, herbivory, rural and urban expansion and climate change. The three villages: Dikgale, Molepo and Makgeng found in Capricorn District in Limpopo Province are home to populations of an unidentified plant, which superficially resembles the Critically Endangered *Euphorbia clivicola* R.A.Dyer and *E. schinzii* Pax (Euphorbiaceae) morphologically. Although Chuene (2016) found the unidentified plants to be closely related to *E. clivicola* than *E. schinzii* genetically, there has never been to our knowledge comprehensive morphological examination, soil analysis and mapping of areas of occurrence of this taxon. We studied the morphology, mapped the area of occupancy and occurrence and analysed soils to determine where this taxon can be placed relative to *E. clivicola* and *E. schinzii* populations. The unidentified populations, henceforth *Euphorbia incertae sedis* (Dikgale/Molepo/Makgeng) were found to be significantly different from *E. clivicola* Dikgale ($P<0.05$). PCA returned three components spanning 74% of total variance while CDFA clearly separated *E. clivicola* Dikgale from *E. incertae sedis* from Dikgale, Molepo and Makgeng regardless of *E. clivicola* Dikgale and *E. incertae sedis* Dikgale's co-occurence. Despite that all populations occur in Mispar soil, *E. incertae sedis* distinctly has early root branching and purple finger edges. It is critical that *E. schinzii* be examined and that *E. incertae sedis* be classified to prevent extinction due to continued anthropogenic disturbances.

## A revision of the *Rhynchosia caribaea* group (Cajaninae, Phaseoleae, Fabaceae) in southern Africa

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The *Rhynchosia caribaea* group is characterised by twining, trailing or climbing stems as well as deltoid, rhomboid or ovate-rhomboid leaflets. The morphological similarities among the species in the group have led to confusion regarding their nomenclature and identification. Here we present a comprehensive taxonomic revision of the species in this group in southern Africa, with an emphasis on nomenclature, typification, phenology, distribution and detailed morphological descriptions, as well as an identification key and information on the species' conservation statuses. The study was based on morphological examination of herbarium specimens and observations made in the field. Our results show that characters such as leaflet size, stipule shape, branching pattern of inflorescences, presence or absence of indumentum on standard petals and fruits, as well as geographical distribution are important in delimiting these species. Pubescent standard petals, wider leaflets (24–90 mm), and inflated fruits are diagnostic of *R. sublobata* while branched inflorescences and pubescent fruits characterise *R. caribaea*. Broad deltoid stipules and unbranched inflorescences are typical of *R. calvescens*. *Rhynchosia atropurpurea* is recognised by its dark purple or maroon keel petals and long (30–42 mm), narrow, oblong-falcate fruits covered with bulbous-based hairs and dotted glands. *Rhynchosia harmsiana* is synonymized with *R. caribaea* due to morphological similarities and geographical sympatry. Furthermore, *R. harmsiana* var. *burchellii*, Burtt Davy is also recognized as *R. caribaea* var. *burchellii* (Burtt- Davy) Ajao & Moteetee *stat. nov.*

## *Zenopus laevis* as UberXL for nematodes

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The effect of invasive species on local parasite dynamics is often overlooked. The global invader *Xenopus laevis* Daudin (Anura: Pipidae) has established populations on four continents and is a domestic exotic in southern Africa. Despite a century of parasitological surveys, the present study reports seven previously undescribed nematode species parasitising *X. laevis* across South Africa. These are: (i) adult *Capillaria* sp. from the intestine, (ii) third stage larvae of *Contracaecum* sp. encysted in the body cavity, (iii) adult *Falcaustra* sp. from the intestine, (iv & v) third stage larvae of *Paraquimperia* sp. and *Tanqua* sp. also from the intestine and (vi & vii) two unidentified species of second stage nematode larvae from the lungs and kidneys. Detailed morphological descriptions, photomicrographs and molecular data of the 18S and 28S rDNA and *COI* genes are provided to aid future investigations. We propose that these nematodes use *X. laevis* as a paratenic, intermediate and, in some cases, definitive host, probably involving native fish, piscivorous birds, aquatic invertebrates and semi-aquatic reptiles in their life cycles. The most widely distributed nematode species was *Contracaecum* sp., a genus which has also been reported to parasitise invasive *X. laevis* in California and Chile. This study illustrates that *X. laevis* is an important parasite reservoir in its native range, with implications for its effects in the invasive range. The fact that none of these nematodes could be identified to species level underscores the importance of providing morphological descriptions and molecular data when reporting on parasitological surveys, especially those of known invasive species.

## Quantification of efforts required for a comprehensive assessment of plant diversity in South Africa

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How many species are there on Earth? Is a fundamental question in science and few studies have explored this question. The most accurate global census approximates life on earth to 8.7 million species. Several studies have pointed out that global approaches to estimating ecological phenomena, specifically extinction risk, may overlook patterns at local scale. The present study aims to estimate the efforts required for a comprehensive biodiversity assessment in a mega-diverse country like South Africa. Here we will make use of PRECIS (a national database), and questionnaires and interviews of expert taxonomists to gather relevant data. The collected data will be analysed using a statistical modelling approach. The results expected for this study is an estimate of the number of plant species that South Africa harbours, as well as the total efforts required to identify the unknown species. This prediction will allow relevant authorities to conserve efficiently South Africa's rich biodiversity and implement protection plans to protect species that are under threat. Solutions to South Africa's biodiversity conservation issues will in due course contribute to the conservation of the global biodiversity.

## The impact of cattle grazing on a recently rehabilitated grassland ecosystem in Mpumalanga

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This study was about the impact of cattle grazing on a recently rehabilitated Block I, former opencast coal mine in Mpumalanga, Witbank coalfield. The area has been rehabilitated by backfilling and levelling of spoil material, subsoil material, placement of approximately 400 mm topsoil layer and grassing. For the purpose of this study, ten ($5 \times 5$ m$^2$) exclosures were erected and cattle were allowed to graze outside the exclosure for a certain period. Two benchmark sites were identified and vegetation surveys were done in two wet seasons. Soil samples were collected and analysed for pH, Ca, Na, Mg, K, P, $NO_3$, $NH_4$ and textural class. Most soil parameters were in an acceptable range when compared to the ideal concentration of the grassland biome. The effect of grazing in Block I was not clear in terms of plant diversity, biomass and ground cover. The reason for this is that two years is not enough to see changes, nor to conclude whether or not the change will be positive or negative. It was also unclear whether Block I is moving towards Benchmark Site 1 or 2 due to the unspecific direction of vector in terms of species composition. It needs more than six years to see the effects of cattle vegetation in disturbed areas like Block I. Rainfall data was considered from the past 30 years, and it was found that during the study period the rainfall in the area was just above the normal range (650–700 mm/year).

## Role and effects of indigenous and exotic southern African ungulates on seed dispersal and germination of select alien invasive fruiting plants: preliminary feedback

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Alien invasive plants (AIPs) are a major threat to biodiversity, human health and the economy. Maintenance of plant populations and dynamic community interactions are generally regulated by seed dispersal. Long-distance seed dispersal is generally associated with avian species as the main vectors, though recent studies have shown that ungulates are also vectors of AIPs. However, the latter is relatively poorly documented. Extensive research is required on ungulate AIPs frequency of feeding, seed retention time and dispersal, and their gut passage effects on germination potential. Here, we determined the role and effects of indigenous and exotic southern African ungulates on fruit ingestion, seed germination and dispersal of select alien invasive fruiting plants. The objectives were: (i) to investigate the community of potential ungulate seed vectors, and (ii) to investigate the effects of ungulate gut passage on germination success and SD potential. Using photographic camera trapping, field assessments for fruit consumption were conducted for 21 consecutive days at a time, followed by the collection of faecal samples from the vicinity of the AIPs. The seeds were harvested for germination trials in a greenhouse with controlled temperature at the University of KwaZulu-Natal, Pietermaritzburg. We found that various ungulate species forage on the fruits of lantana and bugweed. There was greater seed germination for bugweed seeds that had passed through the gut of ungulates than those that were manually de-pulped or seeds in whole fruits. Ungulates form part of the long-distance dispersal network responsible for the spread these AIPs. Further research pertaining to animal tracking may determine the magnitude of AIPs dispersal.

## Effects of habitat-patch size and patch isolation on the diversity of forest birds in five forests in the urban mosaic of Durban, South Africa

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Loss of habitat area and structural heterogeneity through anthropogenic fragmentation pose a threat to the survival of wildlife. We described the effects of forest fragmentation via measures of patch size and isolation on the taxonomic richness and functional richness of forest birds in five forest protected areas within Durban, South Africa. We quantified the avian taxonomic, guild and functional richness and measured at each survey patch. We measured the influence of patch size, isolation distance, patch shape and habitat configuration (i.e. habitat amount on each diversity measure through a series of General Linear Models). We conducted 137 fixed-radius point-count surveys across 41 distinct forest patches during the austral breeding season. The explanatory variables in the top models had a significant effect on all avian diversity measures but habitat amount did not. The amount of habitat surrounding a patch was not significant for measures of bird diversity but based on the Akaike's weight it was important for avian specialist species. Isolation distance did not have a significant effect on the measures of bird diversity. These results show the importance of large forest patches for the conservation of forest birds and maintaining ecosystem functioning and services of forests in increasingly urbanising landscapes.


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