



STARVING FOR DATA AND MORE: WHAT RANGERS AND SCIENTISTS STAND TO LEARN FROM ONE ANOTHER IN SOUTH AFRICA

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A one-year pilot biomonitoring program in Kruger National Park, South Africa – the Kruger Malaise Program – reignites rangers' energy about biodiversity conservation.

Insect biodiversity is understudied and often underappreciated. As evidence for large-scale insect declines emerge, there is an increasing need to address the extreme lack of data on the general ecology and population dynamics of most insect groups. Charismatic species, such as the iconic monarch butterflies (*Danaus plexippus*) of the Americas, are one of the few exceptions.

The caterpillars of the Emperor moth (*Gonimbrasia belina*) are just as iconic and societally relevant on the African continent. Locally referred to as 'mopane worms' after the mopane trees upon which they primarily feed, these insects have been a vital source of protein for generations. A mopane caterpillar contains on average 50 per cent protein¹, a higher percentage than the average steak.

In recent years, mopane caterpillars have also provided an important source of income for many rural communities. It has been estimated that 9.5 billion caterpillars are harvested annually in Southern Africa's 20,000 km² of mopane forest. The ability to predict mopane caterpillar outbreaks in space and time becomes increasingly valuable, particularly for rural communities living along the borders of national parks, who rely heavily on natural resources to supplement their livelihood.

Since 2010, permit-based harvesting projects have taken place in some South African National parks to share benefits and build positive relationships between the parks and their neighbouring communities. With the declining occurrence of mopane caterpillars outside of protected areas due to habitat change and

over-harvesting, and the overall erratic nature of recent outbreaks, neighbouring communities risk losing an important source of food and income.

A better understanding of insect dynamics has the potential to inform the sustainable harvest of natural resources such as the mopane caterpillar, but it also tells us a lot more.



Mopane worm harvest in Kruger National Park, South Africa.
PHOTO CREDIT: Luise Swemmer

A pilot insect biomonitoring program in Kruger National Park, South Africa – the Kruger Malaise Program – is already demonstrating implications for natural resource harvesting, as well as agricultural pest and disease management. Perhaps even more significant, it has reignited energy in park rangers about biodiversity conservation.

The Kruger Malaise Program (KMP), a year-long monitoring effort, was undertaken in Kruger Park from May 2018 to June 2019. With the main goal of understanding insect diversity and seasonal variation, the program deployed 26 Malaise traps that sampled the flying insect community in all 22 sections of the park. Traps were set up within each section ranger's property, and rangers were tasked with organizing and maintaining weekly sample collections. The samples were then retrieved in four large batches over the year by staff from the African Centre for DNA Barcoding (ACDB) in Johannesburg, South Africa, where they were packaged and shipped to the Centre for Biodiversity Genomics (CBG) in Guelph, Ontario, Canada for DNA barcode analysis. This program was only possible due to the collaborative efforts of park rangers and staff, researchers at the Savanna & Arid Research Unit in Skukuza, Kruger, and scientists at the ACDB and CBG.

With sampling now complete, analysis has begun in earnest. So far, more than 260,000 specimens have been processed, and 170,000 have been sequenced. Preliminary results have delivered barcode coverage for 9,000

species including various agricultural pests (e.g., the olive fruit fly (*Bactrocera oleae*), and the rusty plum aphid (*Hysteroneura setariae*)) as well as several vector species known to transmit the bluetongue and African horse sickness viruses (e.g., *Culicoides imicola*) and West Nile Virus (*Culex perexiguus*). When compared against the DNA barcode database (BOLD Systems) of more than 600,000 species, almost half of the insect diversity uncovered by the program so far is only found in Kruger.

Based on species accumulation rates, it is likely that 25,000 species will be recorded in the park. This number represents more than half of the species previously reported from South Africa², and quarter of those described in sub-Saharan Africa³.

The Kruger Malaise Program reveals just how quickly DNA barcoding can provide in-depth and broad-scale information for regions where past research has largely been focused on particular taxonomic groups. While one of the only comprehensive field guides for insects in South Africa contains 1,200 species – those that are ‘abundant, widespread, conspicuous, large or unusual’ – the Kruger Malaise program has largely uncovered the rare, small, inconspicuous, yet ecologically important, species.



The African Centre for DNA Barcoding (ACDB) team after collecting the last Malaise trap at the end of the KMP in June 2019: Zandisile Shongwe, Nolo Sello, Michelle van der Bank (ACDB Director), Ross Stewart, Jonathan Davies (top left to right), Johandre van Rooyen (bottom).

PHOTO CREDIT: Nolo Sello

In 2013, SANParks developed a biodiversity monitoring strategy but its activation has been very mixed across the 19 parks. Some began their monitoring efforts by focusing on rare species, while others used key indicator groups. But there have been no standardized techniques implemented across all parks, and there has been little monitoring of insects at a large scale, mainly because of the lack of taxonomic expertise.



The park rangers and staff who managed the Malaise traps in Kruger National Park.

PHOTO CREDIT: Michelle D'Souza

A program involving DNA technology makes large-scale biomonitoring of these national parks possible.

The KMP has been a huge success with the next steps set to fine tune logistics before its expansion to other parks and, ideally, to identify specific sites in Kruger for ongoing monitoring. The program also provided a test bed for TRACE (Tracking the Response of Arthropod Communities to Changing Environments), a major research theme within the 7-year, \$180 million BIOSCAN program. Its success has demonstrated the feasibility of extending this work in other national parks within South Africa and on a global scale. In doing so, BIOSCAN will lay the foundation for a DNA-based global biodiversity observation system, similar to the monitoring systems that have been recording weather patterns since the 1800s. BIOSCAN has a grand vision, one that is necessary if we are to truly identify, understand, and manage the global decline in insects.

But if you ask the people working in Kruger, the KMP was more than a biodiversity monitoring program. Most rangers start out as nature conservation and zoology students, but anti-poaching efforts are so time consuming that their roles have gone from biodiversity managers to single-species protectors. The

KMP has not only sparked interest and reignited energy in the park rangers about their conservation work, it has engaged and valued the observational and experiential data that rangers have to offer, such as stories and strategies related to the mopane caterpillars.

In this way, the KMP has made a very big impact – and that is the true beauty of the program – its ability to spur interest in insect life, and the patterns and processes that define our world.

References:

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