

A decade (and a half) of microbial ecology research in the McMurdo Dry Valleys

Cowan Don A.

Centre for Microbial Ecology and Genomics, University of Pretoria, Pretoria, South Africa

don.cowan@up.ac.za

The McMurdo Dry Valley of eastern Antarctica represent a substantial proportion of the continent's ice-free land. Dry Valley mineral soils are widely considered to represent one of the most hostile environments on Earth. Although once considered to be effectively sterile, these soils are now known to host substantial populations of bacteria ($>10^6$ cells g^{-1} : [1]) and a wide species diversity [2]. The Dry Valleys are also characterised by specialised cryptolithic niche habitats (particular endoliths and hypoliths [3]) which play important roles in regional ecosystem services [4]. Over the past 15 years, we have contributed to an increasingly comprehensive understanding of the structures [5-8], drivers [9], assembly processes [10] and adaptations [11,12] of microbial communities in Antarctic cold desert soils. The use of modern molecular phylogenetic survey methods, coupled with *in situ* and *ex situ* analyses of community function and adaptation, have led to the concept that despite the extreme abiotic properties of this desert ecosystem, these depauperate soils support a wide microbial [2], viral [8] and microeukaryote [7] species diversity. With our entry into the field of full metagenome sequence analysis and comparative metagenomics, we have obtained some insight into the metabolic capacity of Dry Valley microbial communities [13, 14], including the degree of metabolic redundancy and the breadth of molecular adaptation strategies employed by these organisms.

- [1] Cowan, D.A., Mamais, A. Sheppard, D, Russell, N (2002) Antarctic Dry Valley mineral soils contain unexpectedly high levels of microbial biomass. *Extremophiles* 6:431-436.
- [2] Smith, JJ, Ah Tow, L, Stafford, W, Cary, C, Cowan, DA (2006) Bacterial diversity in three different Antarctic cold desert mineral soils, *Microb. Ecol.* 51:413-421.
- [3] Van Goethem M, Makhalanyane T, Valverde A, Cary S, Cowan D. (2016) Characterization of bacterial communities in lithobionts and soil niches from Victoria Valley, Antarctica. **FEMS Microb Ecol.** In Press
- [4] Cary, SC, McDonald, I, Barrett, JE and Cowan, DA. (2010) On the rocks: Microbial ecology of Antarctic cold desert soils. **Nature Rev. Microbiol.** 8:129-138.
- [5] Babalola, OO, Kirby, BM, Le Roes-Hill, M, Cook, AE, Cary, SC, Burton, SG, Cowan, DA. (2009) Phylogenetic analysis of actinobacterial populations associated with Antarctic Dry Valley mineral soils. **Envir. Microbiol.** 11:566-576
- [6] Wood SA, Rueckert A, Cowan DA, Cary SC. (2008) Aquatic cyanobacteria, important contributors to edaphic cyanobacterial diversity in the Dry Valleys of Eastern Antarctica? **ISME J.** 2:308-320
- [7] Gokul, JK, Valverde, A, Tuffin, M, Cary, SC, Cowan, DA (2013) Micro-eukaryotic diversity in hypoliths from Miers Valley, Antarctica. **Biology** 5: 331-340
- [8] Zablocki O, van Zyl L, Adriaenssens EM, Tuffin IM, Cary SC, Cowan DA. (2014) High-level diversity of tailed phages, eukaryotic-associated viruses and viroplasm-like elements in the metaviromes of Antarctic soils. **Appl. Environ. Microbiol.** 80: 6888-6897
- [9] Stomeo, F, Makhalanyane, T, Valverde, A, Pointing, S, Stevens, M, Cary, SC, Tuffin, Cowan, DA (2012) Abiotic factors influence microbial diversity in permanently cold soil horizons of a maritime-associated Antarctic Dry Valley. **FEMS Microb. Ecol.** 82: 326-334
- [10] Makhalanyane, TP, Valverde, A, Birkeland, N-K, Cary, SC, Tuffin, IM, Cowan, DA (2013) Evidence for successional development in Antarctic hypolithic bacterial communities. **ISME J.** 7:2080-2090
- [11] Tiao, G, Lee, CK, McDonald, IR, Cowan, DA, Cary, SC (2012) Rapid microbial response to removal of the presence of an ancient relic in the Antarctic Dry Valleys. **Nature Comms.** 3: 360
- [12] Aliyu H, De Maayer P, Cowan DA (2016) The genome of the Antarctic polyextremophile *Nesterenkonia* AN1 reveals adaptive strategies for survival under multiple stress conditions. **FEMS Microb Ecol.** In Press
- [13] De Maayer, P, Anderson, DE, Cary, SC, Cowan, DA, (2014) Some like it cold: understanding the strategies of psychrophiles: **EMBO Rep.** 15: 508-517
- [14] Vikram S, Guerrero L, Makhalanyane TP, Le P-T, Seely M, Cowan DA. (2015) Metagenomic analysis provides insights into functional capacity in a hyperarid desert soil niche community. **Environ. Microbiol.** In Press