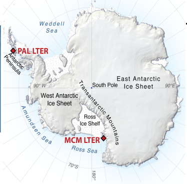
The McMurdo Dry Valleys Long Term Ecological Research Project



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20th MCMLTER 1992-2012

Overview

The McMurdo Dry Valleys (MDV) is a polar desert on the coast of East Antarctica which has not yet experienced climate warming. The MCMLTER project has documented the ecological responses of the glacier, soil, stream and lake ecosystems in the MDV to a cooling trend (1986 to 2000), which was associated with the depletion of atmospheric ozone. Recently, high flows and strong katabatic winds have occurred during three summers and changed the landscape, enhancing ecological connections.

Fig 1 .Map of Taylor Valley (showing Bonney, Hoare, and Fryxell Basins) and Wright Valley indicating the distribution of monitoring and experiment locations.

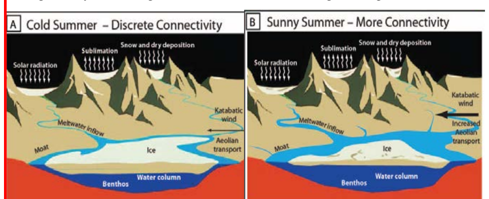

Fig 2 .Schematic diagram of Dry Valleys contrasting cold to sunny summers.

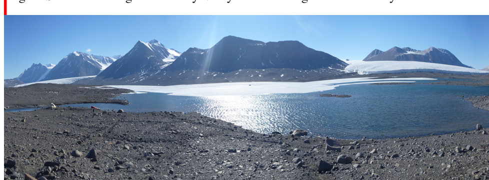

Fig 3 .Lake Fryxell, Taylor Valley

Central Hypothesis

The central hypothesis of current MCMLTER research is: Climate warming in the McMurdo Dry Valley ecosystem will amplify connectivity among landscape units leading to enhanced coupling of nutrient cycles across landscapes, and increased biodiversity and productivity within the ecosystem.

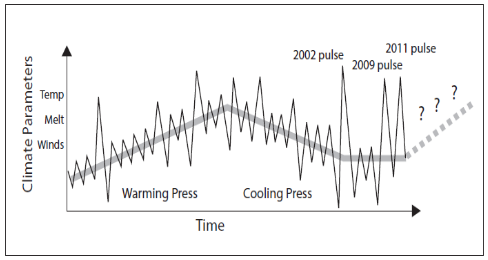

Fig. 4.Conceptual model of climate driven presses and pulses in the MDV ecosystem.

Eventual warming in the MDV with the amelioration of the ozone hole is hypothesized to act as a slowly developing, long term press of warmer summers, interrupted by transient pulse events of high summer flows and strong katabatic winds.

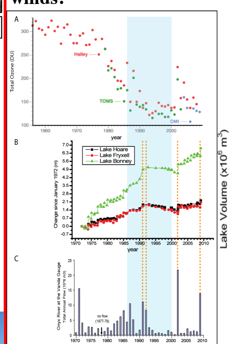

Fig 5.(A) Ground based and satellite measurements of ozone concentrations over Antarctica.(B) Taylor Valley lake levels changed inversely with ozone concentration from 1970 to 1990.(C) Total annual flow of Onyx River from 1970 to 2009.

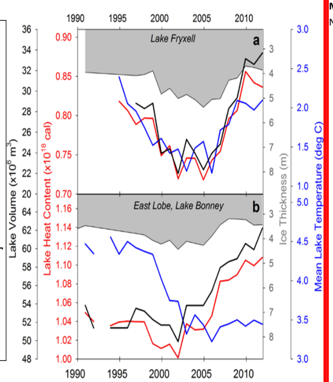

Fig 6.Decadal changes in lake volume, heat content, ice thickness (gray fill), and volume-weighted mean temperature for (a) lake Frxyell and (b) East Lobe of Lake Bonney.B

Biota, Abundance, and Diversity

Contemporary patterns in distribution of biota in the MDV are used to understand underlying ecological connectivity. Although the abundance and diversity MCM DV biota is low relative to most other ecosystems, recent and ongoing work reveals that representative taxa from most of the major lineages of the Tree of Life are present and functioning. Diatoms in particular serve as excellent indicators of environmental change, and MCM DV diatoms showcase this utility via the Antarctic Freshwater Diatom Database

Bacteria: Although taxonomic diversity is lower than most ecosystems, functional diversity in the MCM can be as high as temperate forests. Diversity and endemism is higher than previously thought, and highly structured by landscape unit.

Archaea: Present in Lake Mat samples (Lake Fryxell moat), Lake Fryxell deep anoxic water and lake sediments, and a minor component of soil.

Viruses: Lysogneic bacteria can make up to 89% of bacterioplankton

Fungi & Yeasts: 7 endemic fungal species, one genus, 35 cosmopolitan genera; present in soils and lakes; 2 genera (5 species) of endemic yeasts.

Protozoa (Ciliates, Cercozoa & Dinoflagellates): restricted to moist soils, streams & lakes; no known endemic morphospecies.

Diatoms (Stramenopiles): 62 species; distribution varies by environmental harshness: endemic species are common.

Bryophytes: Dominant species (*Bryum argenteum, B. pseudoturquetrum and Ceratodon purpureus*) are widespread throughout Antarctica.

Cyanobacteria, Algae & Lichens: 20 species of lichens, only 11 on thevalley floor; the most common microbial mats in the streams and moats are black (*Nostoc sp.*), orange (*Oscillatoria spp., Phormidium spp*) and green (*Prasiola calophylla, P. crispa*).

Metazoa: Tardigrada (8 species), Rotifera (4 species) Nematoda (5 species), Collembola (one species), Acari

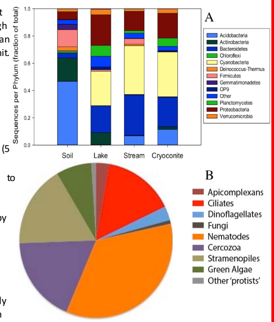

Fig 7.Abundance and diversity of (A) major taxa and (B) eukaryotes in MCM Dry Valley Soils

Cyanobacterial filament: *Nostoc* sp. Tardigrade: *Milnesium* sp. Nematode: *Scottnema lindsayae*

Endemic diatom abundance in streams

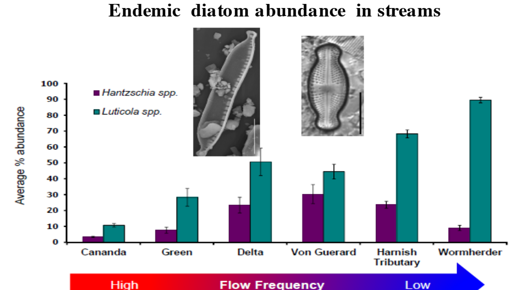

Fig 8.Flow frequency variability in Lake Fryxell streams (high – flows every season, for most of the season, low – flows most seasons, for part of the season) and diatom abundance response.

Response to Change

High flows were found to suppress invertebrate abundance in algal mats despite similar chlorophyll-a content.

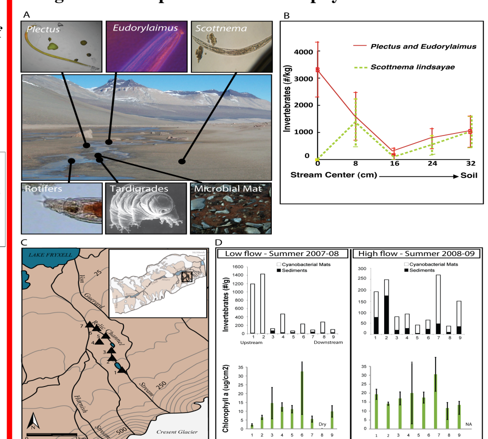

Fig 9.Changes in invertebrates and microbial mats in the Relict Channel Reactivation Experiment. (A) Habitat preferences of invertebrates in MDV streams (B) Variation in abundance of invertebrates with distance from stream center. (C) Site map, site 1 is just below diversion. (D) Changes in invertebrate abundance in cyanobacterial mats and sediments between low flow and high flow summers.

Changes in connectivity are hypothesized to be mediated by geographic variation among valleys.

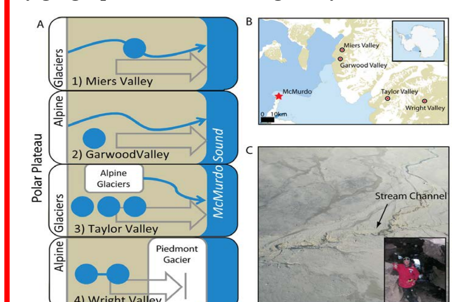

Fig 10.(A) 1) aeolian (gray arrow) and freshwater fluxes interact with flow-through lake, 2) aeolian and freshwater fluxes from distal sources carried by a large stream, 3) aeolian and freshwater fluxes from near- coast sources with closed basin lakes, and 4) piedmont glacier blocks all but aeolian sources.(B) Location map of MDV. (C) Thermokarst erosion of Garwood Stream after a warm summer hydrological pulse event.