Time to focus on function?

Linking microbial community structure to novel aspects of microbial function

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The state of microbial ecology, *circa* 2009

To date, most of our attention has been on describing patterns in community structure.
Is it time to focus on function?
Do different communities function differently?

**Traditional focus: function**
- Potential rates under optimal conditions
- Actual net rates under one set of field conditions

**Traditional focus: communities**
- DNA based assessment of total community composition
Do different communities function differently?

Traditional focus

• Potential rates at optimal conditions

Example: Denitrifier community structure relates to potential denitrification rates in urban streams.

Wang, S., J. Wright, E. Bernhardt, and M. Wallenstein, unpublished data.
Microbes in current terrestrial ecosystem models
Do different communities function differently?

Emerging focus: function

- The range of conditions under which a particular function can occur (functional plasticity).
- The persistence of function in the face of stress or disturbance.

Emerging focus: community composition

- Assessing the ACTIVE microbes under different conditions with RNA or other novel molecular approaches (Stable Isotope Probing, BrdU)
In terms of niche theory...

Abiotic condition
(e.g. pH, temperature, moisture availability)

Activity Rate
(e.g. denitrification, respiration)

Community physiological response curve (PRC)

Species-specific PRC
Under optimal conditions, no effect of community composition on activity rate.
Under in-situ conditions, direct effect of community composition on activity rate.

Microbial composition affects the range of conditions under which microbial functions can persist.
Soil Temperature @ 5 cm 2004-2005
Toolik Lake, Alaska
Bacterial community composition

Wallenstein et al 2007 FEMS Micro Ecol
The ACTIVE microbial community appears to be more seasonally dynamic.

McMahon, Wallenstein, and Schimel. In prep.
Lignocellulose degrading enzymes peak in late winter.

Seasonal changes in enzyme temperature sensitivity

- Winter enzymes are more sensitive to temperature than summer enzymes!
- Suggests that different organisms are producing different iso-enzymes at different times of the year.

Modeled in-situ enzyme activities

Winter

Microbial Activity

Fungi and Gram (-) bacteria
Degrading Lignocellulose

Temperature
Early Summer

Diverse microbial community
Degradating chitin, protein, hemi-cellulose

Microbial Activity

Temperature
The challenge...

Study the physiology of microbial communities under a range of abiotic conditions to improve our ability to predict ecosystem function in the face of environmental change.
Emerging goals for microbial ecologists (2010-2020)

1. Identify which microbes are active under different in situ conditions.
2. Understand the physiology and ecological roles of different microbial taxa.
3. Measure and model how microbial physiology affects the dynamic response of ecosystem function to changing environments.
Function