Role and potential impact of thermophilic microorganisms in temperate terrestrial environments during extreme conditions

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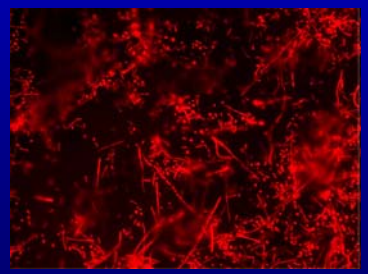

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Introduction

- Microorganisms play far more important ecological roles than their small size would suggest
- Life in our planet will be impossible without microorganisms
- Microorganisms are intimately involved in biogeochemical processes
- For many elements, microorganisms are the only biological agents capable of carrying out specific transformations

Examples: Methane production

Anaerobic respiration (nitrate, sulfate, carbonate, organic compounds)

N_2 fixation, nitrification, denitrification

S^o-oxidation, dissimilative sulfate reduction

Metal oxidation/reduction

Numerous biodegratation pathways

Introduction

- Microbial diversity exceeds expectations

There is a similar number of microbes in 10 g of soil than stars in our galaxy

(Curtis & Sloan, 2005; Science 309: 1331)

Stars

Microbes

(DAPI staining)

Introduction

- Microorganisms can develop in almost every site on Earth
- A number of microorganisms inhabit extreme environments

  They are named "Extremophiles"

High temperatures (up to 113°C)	Thermophiles
Low temperatures (below 0°C)	Psychrophiles
High pH (above 9)	Alkalophiles
Low pH (below 3)	Acidophiles
High salinity	Halophiles
Elevated pressure	Barophiles

- There is life beyond what we can imagine

Introduction

- Thermophiles in temperate environments

  Present in soils (Marchant *et al.*, 2002; Environ. Microbiol. 10: 575)

- Current predictions propose an increase of temperature during this century

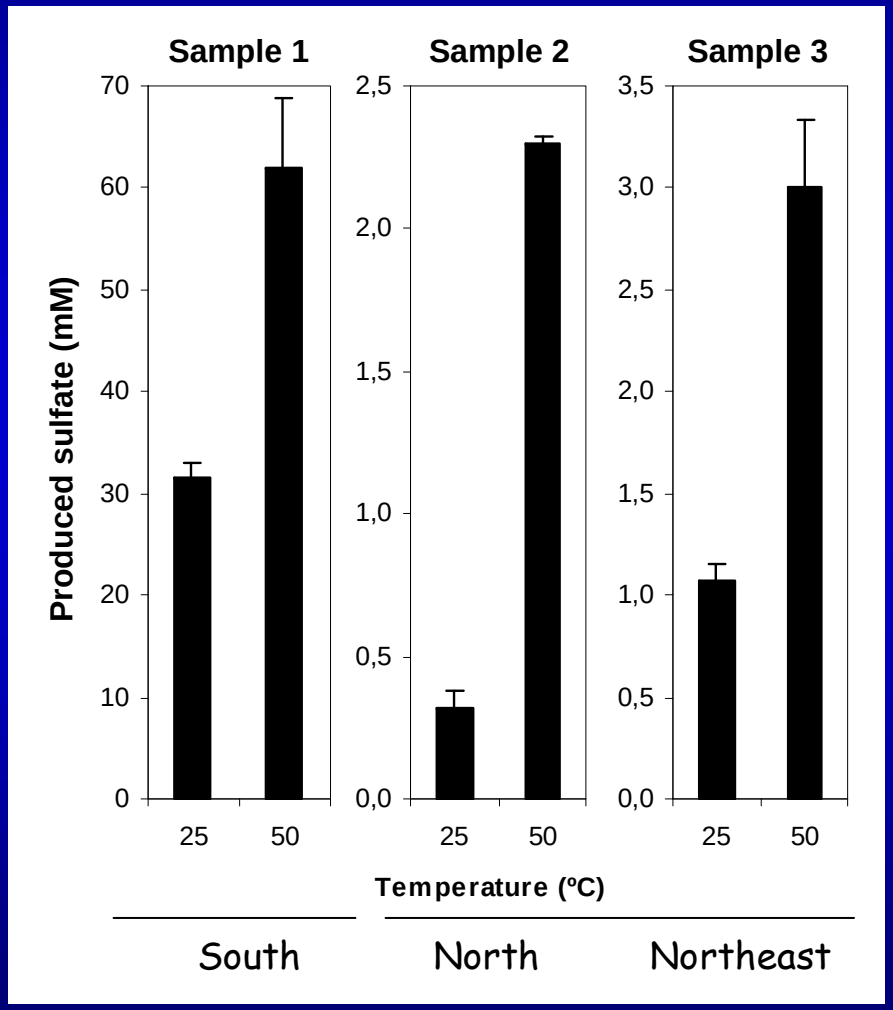
- More frequent extreme temperature conditions/events are expected

- Questions to approach:

  - Do they carry out ecological roles?
  - Can the necessary conditions for thermophiles occur?

Results & Discussion

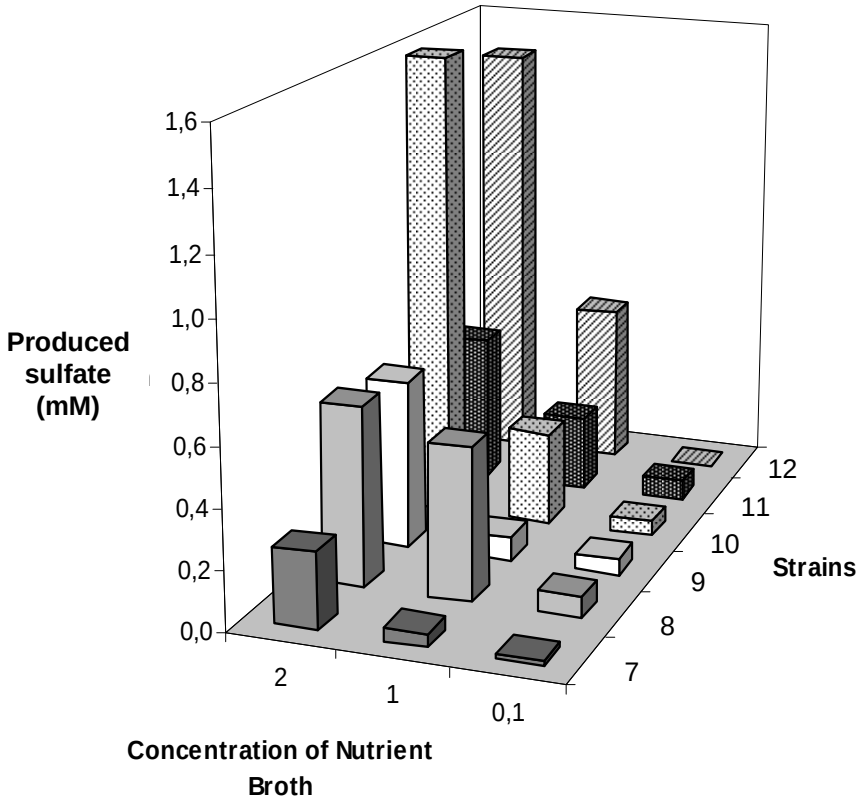
Experiments with natural microbial assemblages

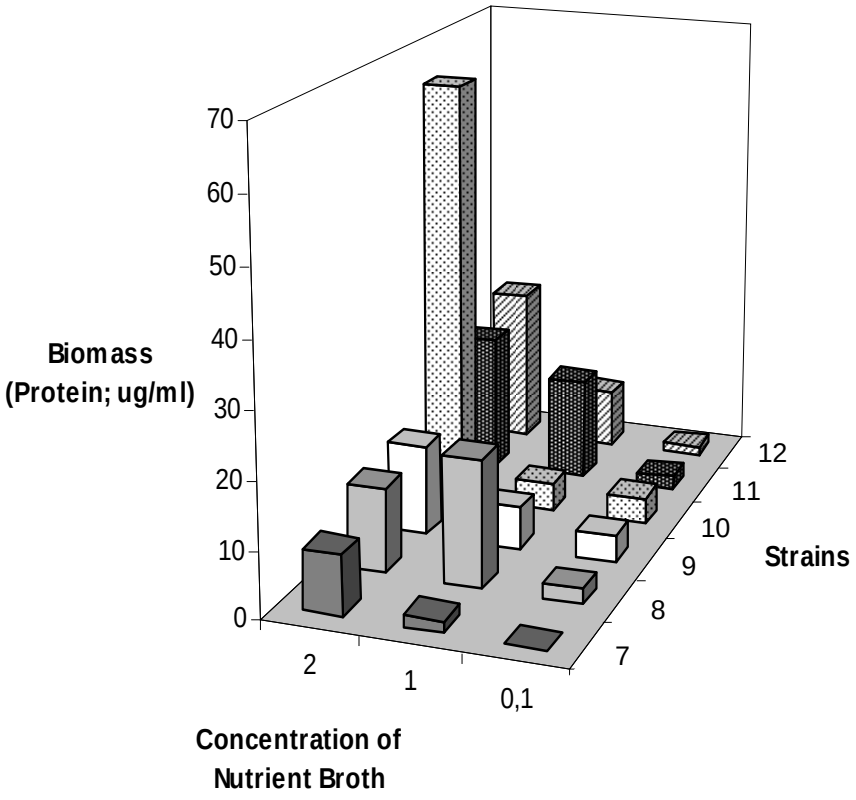


At elevated temperatures S mineralization (sulfate) was higher than at lower temperatures

Results & Discussion

Sulfate released by thermophiles depends on organic matter



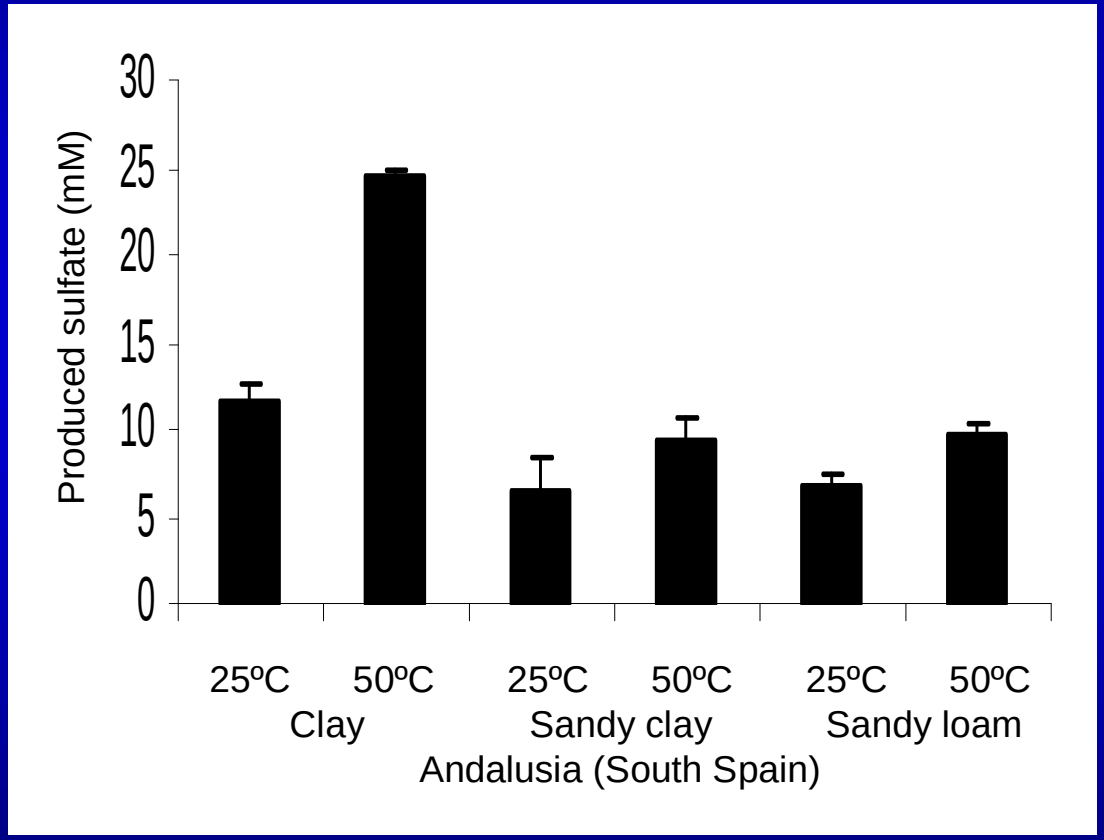


Thermophilic isolates. Firmicutes: 7, 8, 9, 11, *Geobacillus;* 10, *Brevibacillus;* 12, *Ureibacillus*

Most S in soils (>90%) is in the organic matter fraction

Results & Discussion

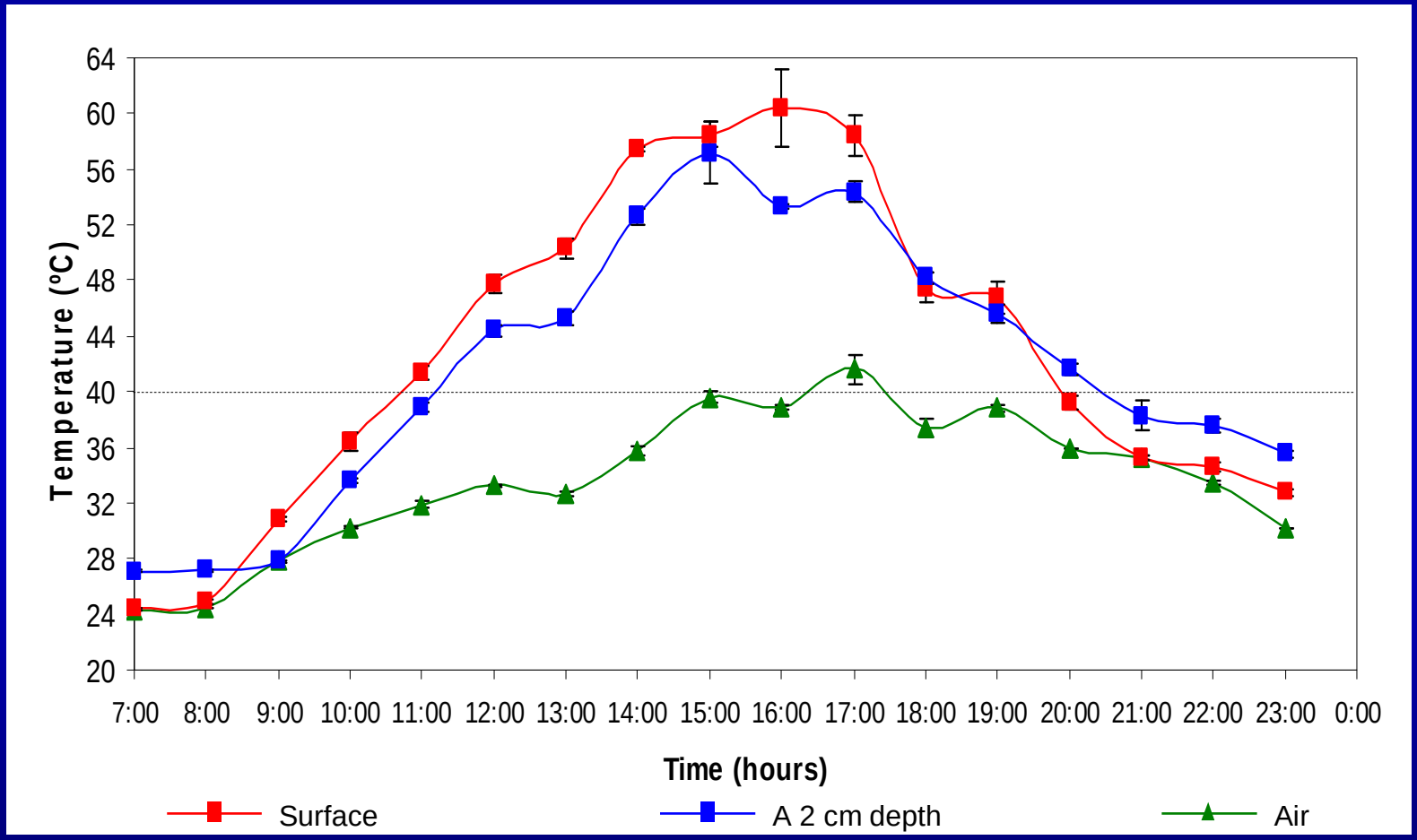
During organic matter consumption ammonium was also released



N mineralization (NH_4^+) at high temperature was similar or higher than at lower temperatures

Results & Discussion

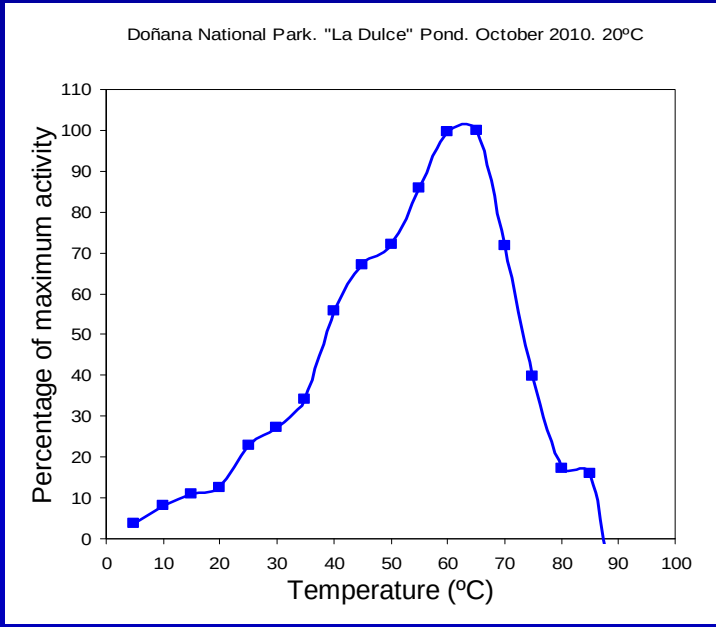
Can temperature get high enough for thermophiles to grow?

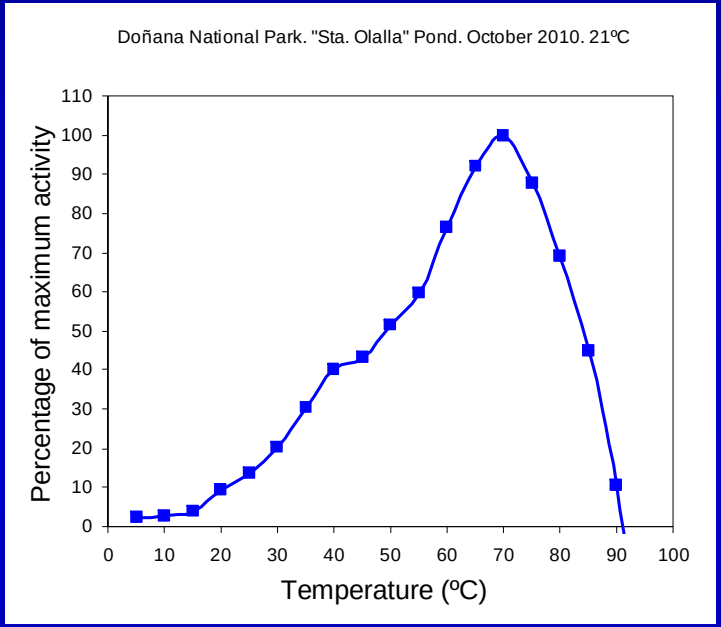


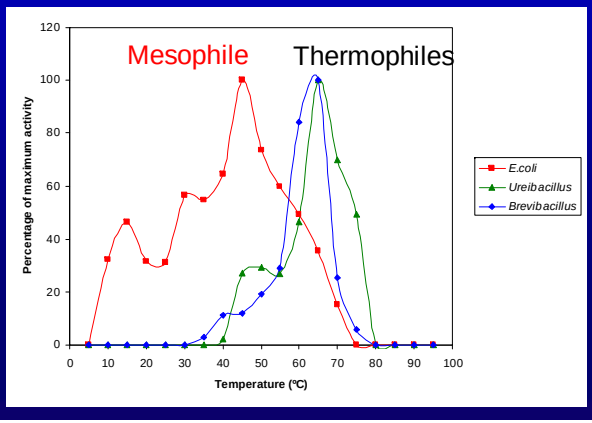
Temperature can reach values adequated for thermophiles

Results & Discussion

Is *in situ* thermophilic activity significant? Example: Protease activity







In situ degradation of organic compounds increases as temperature increases in soils and sediments

Conclusions

- Thermophiles have a niche of opportunity to develop in temperate systems
- Thermophiles can significantly enhance C, N, and S mineralization in soils and sediments
- *In situ* organic matter decomposition increases as temperature increases
- Increase of temperature will result in a higher contribution of thermophiles to C, S and N cycling in temperate environments

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