

Microbiologia degli Ambienti Marini Idrotermali

PARTE B

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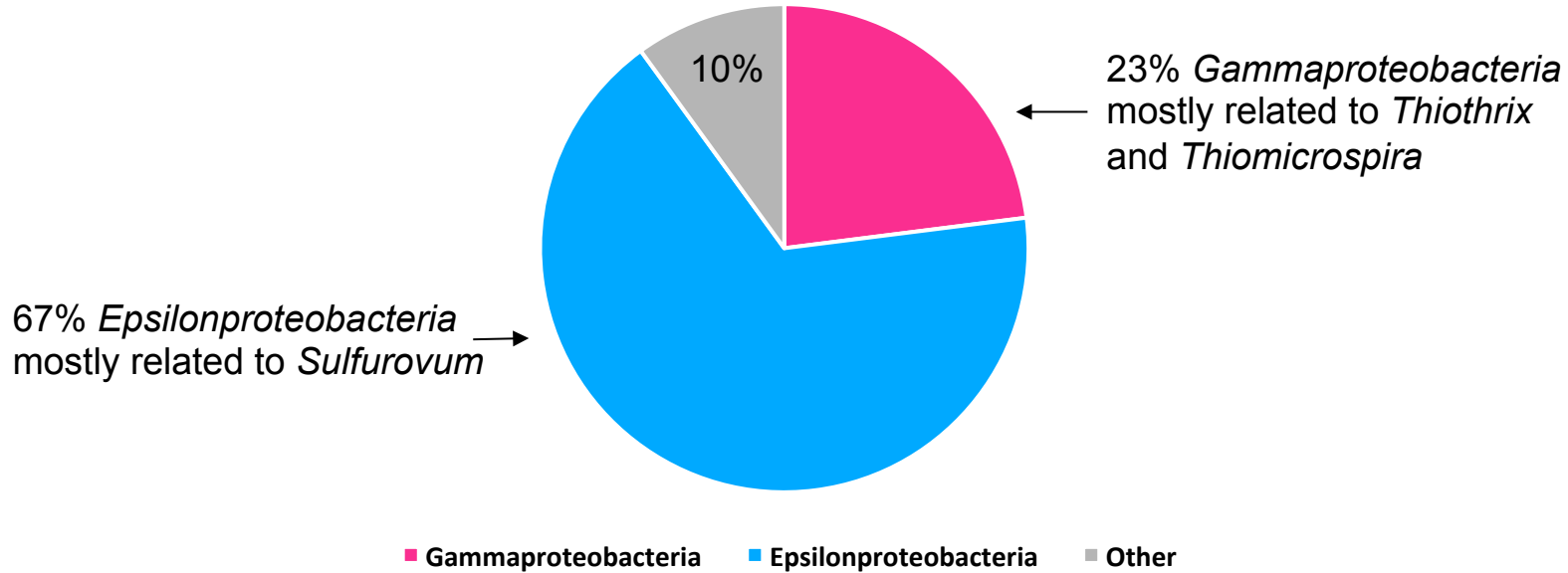




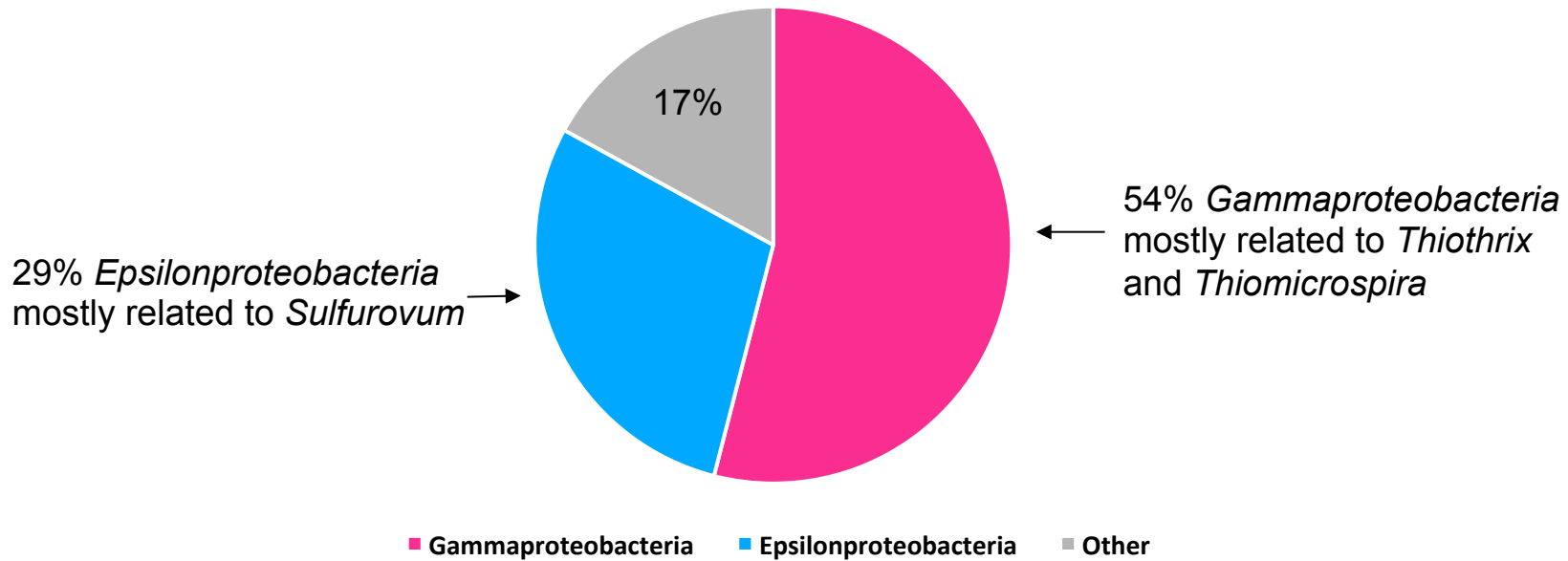
Broader relevance

- Knowing how much CO₂ is vented at coastal geothermal habitats - along with a better understanding of the extent of such systems - will help us constrain the carbon flux from the lithosphere to the atmosphere
- Study on the physiology and metabolism of chemosynthetic bacteria isolated from these environments will help us understand their contribution to the global carbon budget

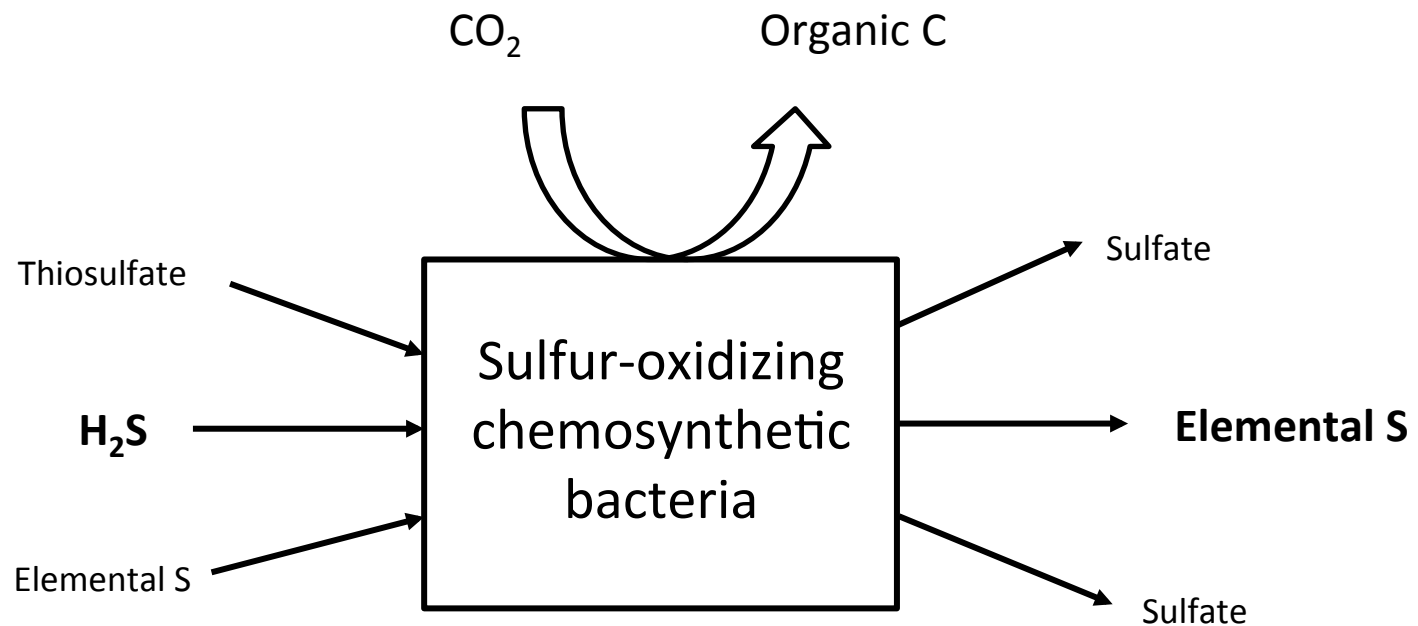
Young filament community (metagenome)



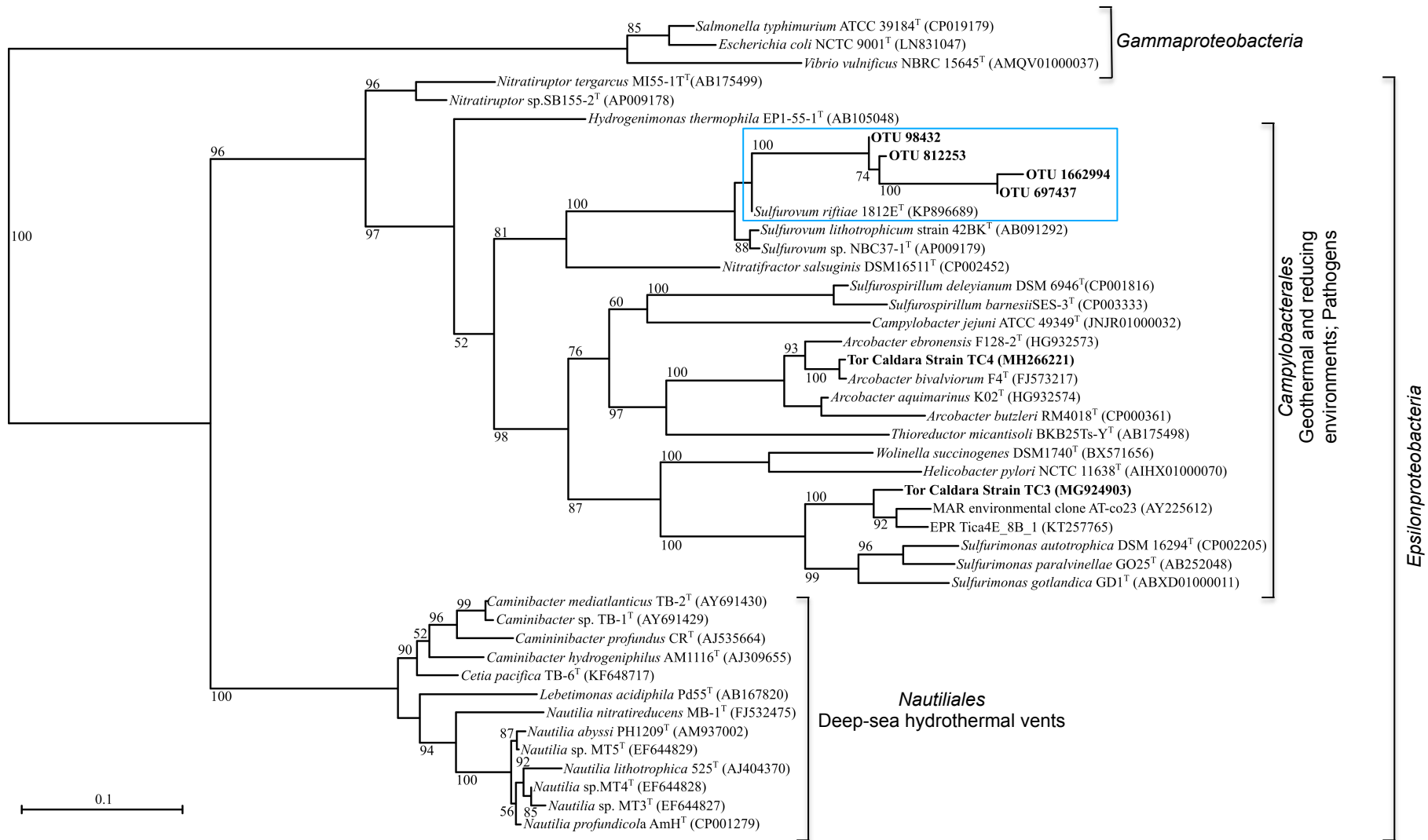
Established filament community (metagenome)



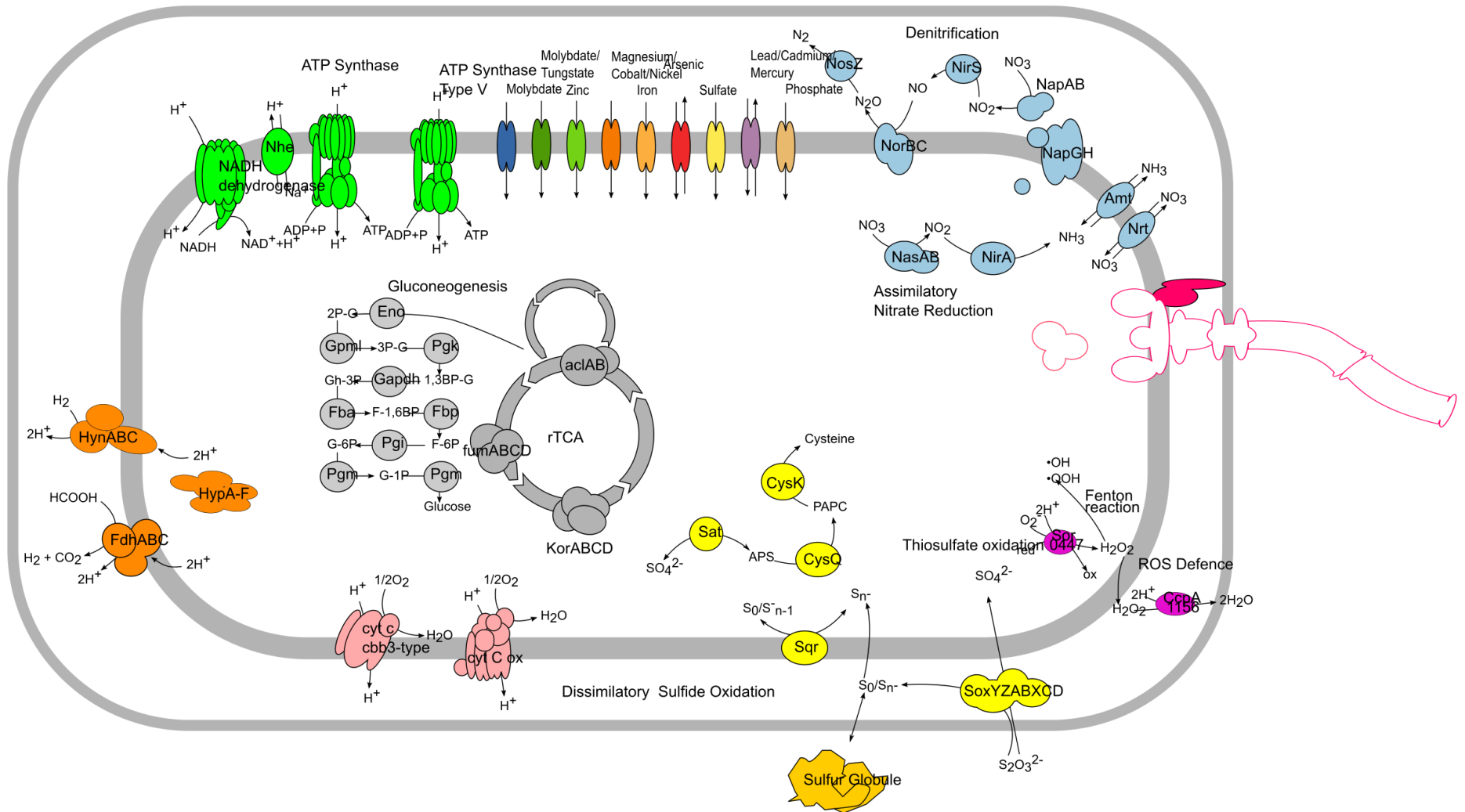
Chemolithoautotrophic sulfur oxidation



Epsilonproteobacteria from Tor Caldara

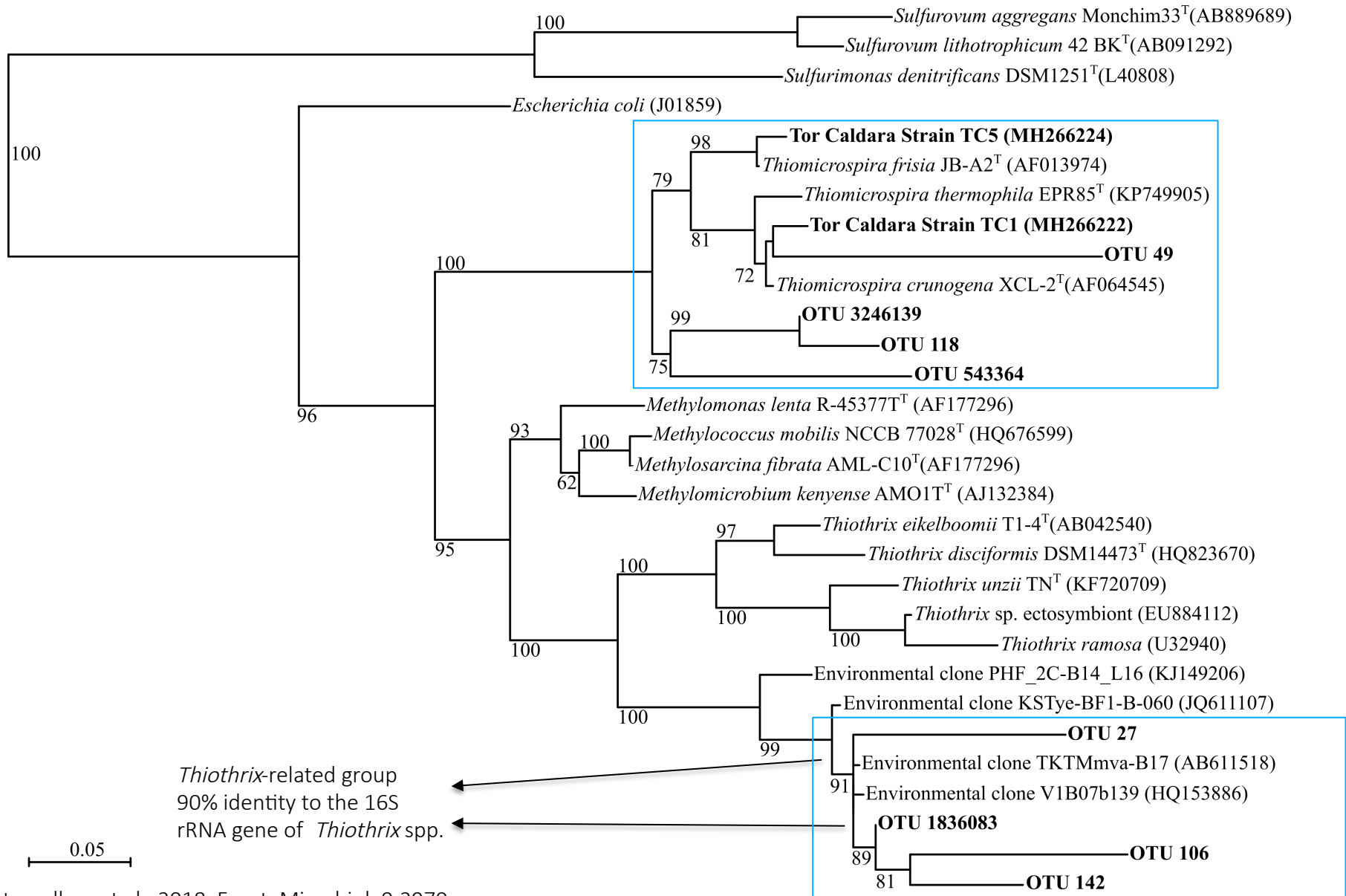


Sulfurovum riftiae (Epsilonproteobacteria) genome



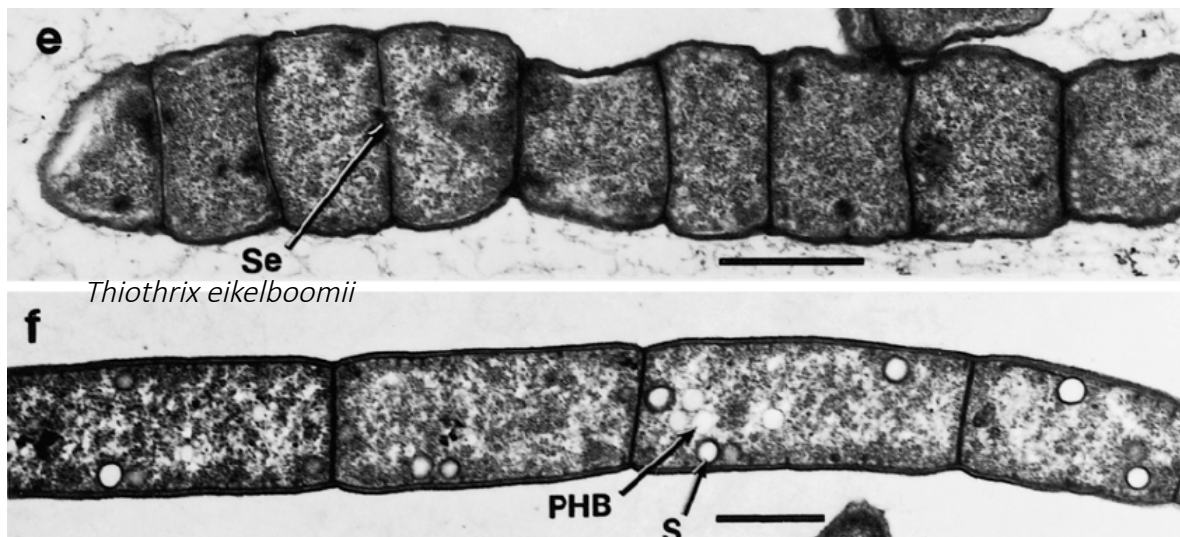
Giovanelli et al., 2016 and Giovanelli et al., in preparation

Gammaproteobacteria from Tor Caldara



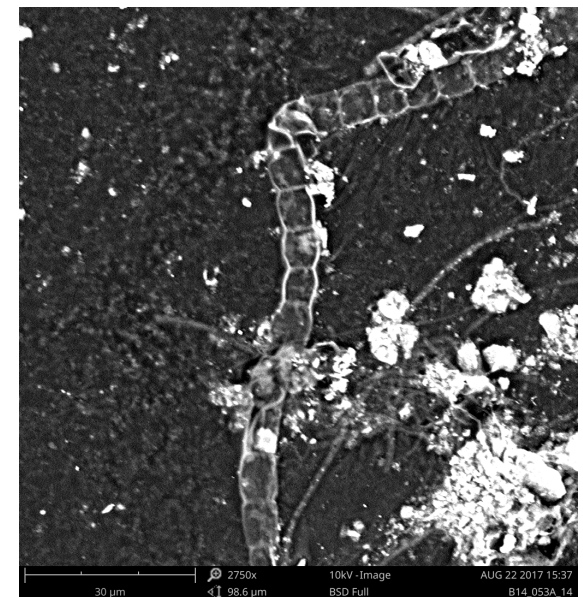
Thiothrix and *Thiomicrospira* (Gammaproteobacteria)

- Found in sulfidic waters
- Facultative or obligate autotrophs (RubisCo activity - CBB cycle)
- Sulfide oxidizers; deposit sulfur globules
- Aerobic or microaerophilic
- *Thiothrix*:
- Originally studied by Winogradsky in 1888
- Mostly morphology-based studies
- Gliding motility
- Ability to attach to substrates



Williams et al., 1987, AEM. © American Society for Microbiology

Thiothrix-like filaments from Tor Caldara



Niche partitioning of Epsilon- and Gammaproteobacteria in geothermal environments

- Epsilon- and Gammaproteobacteria in sulfidic environments occupy niches that differ in sulfide concentration (e.g.: Engel et al., 2004; Macalady et al., 2008; O'Brien et al., 2015; Gulmann et al., 2015; Miranda et al., 2016; Meier et al., 2017)
- Correlative observations based on microbial diversity surveys and co-registered sulfide measurement suggested the following sulfide ranges: Gammaproteobacteria: 0 – 100 μM ; Epsilonproteobacteria: 100 – 750 μM

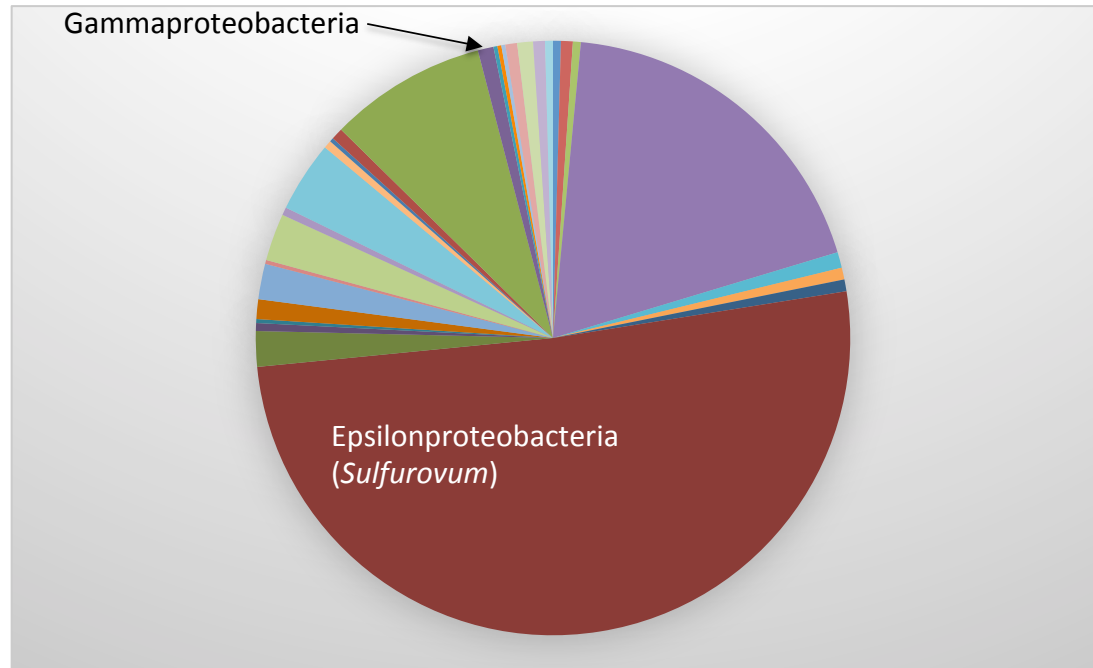
Niche partitioning at deep-sea vents

Habitat characteristics

Temperature: 15°C

[H₂S]: 60 – 80 μM

pH: 6.2-6.8

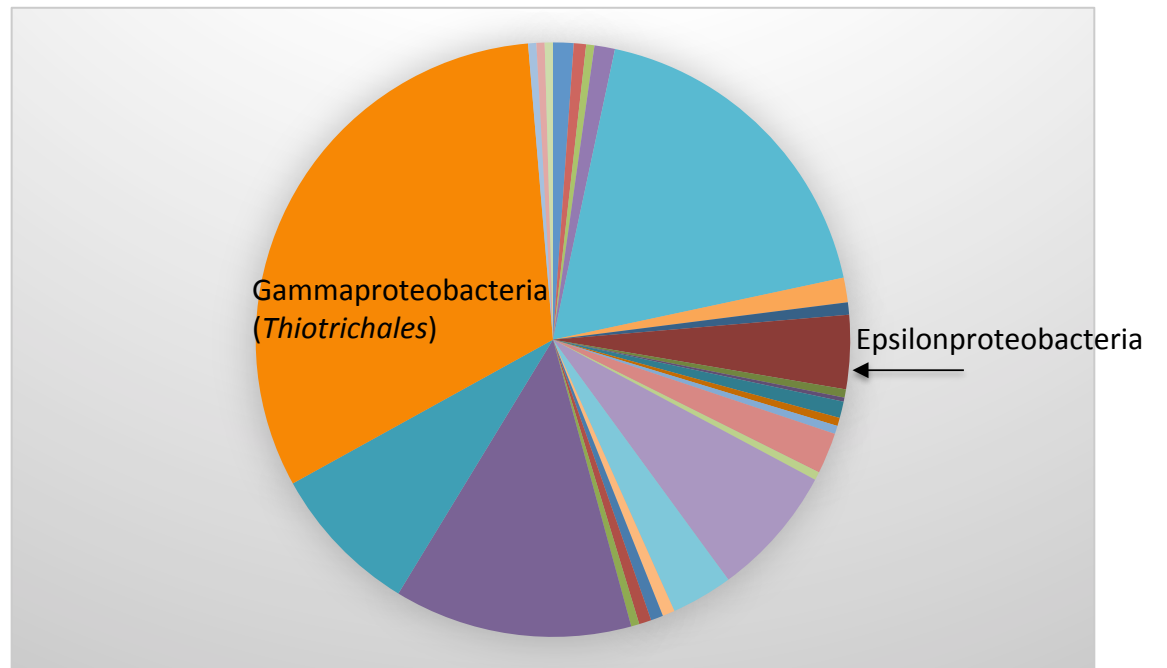


Habitat characteristics

Temperature: 6°C

[H₂S]: 7-8 μM

pH: 7

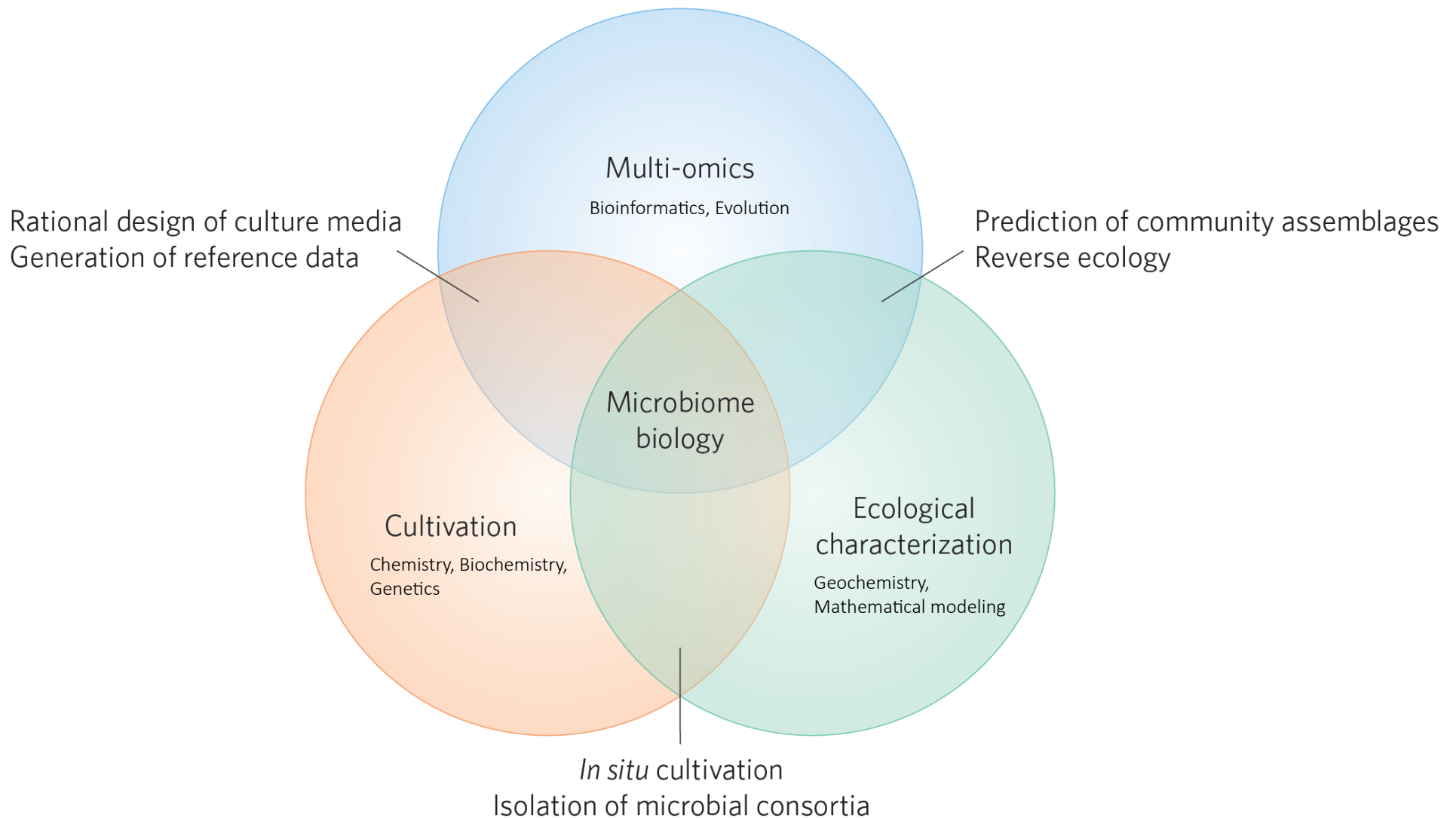


Hypothesis

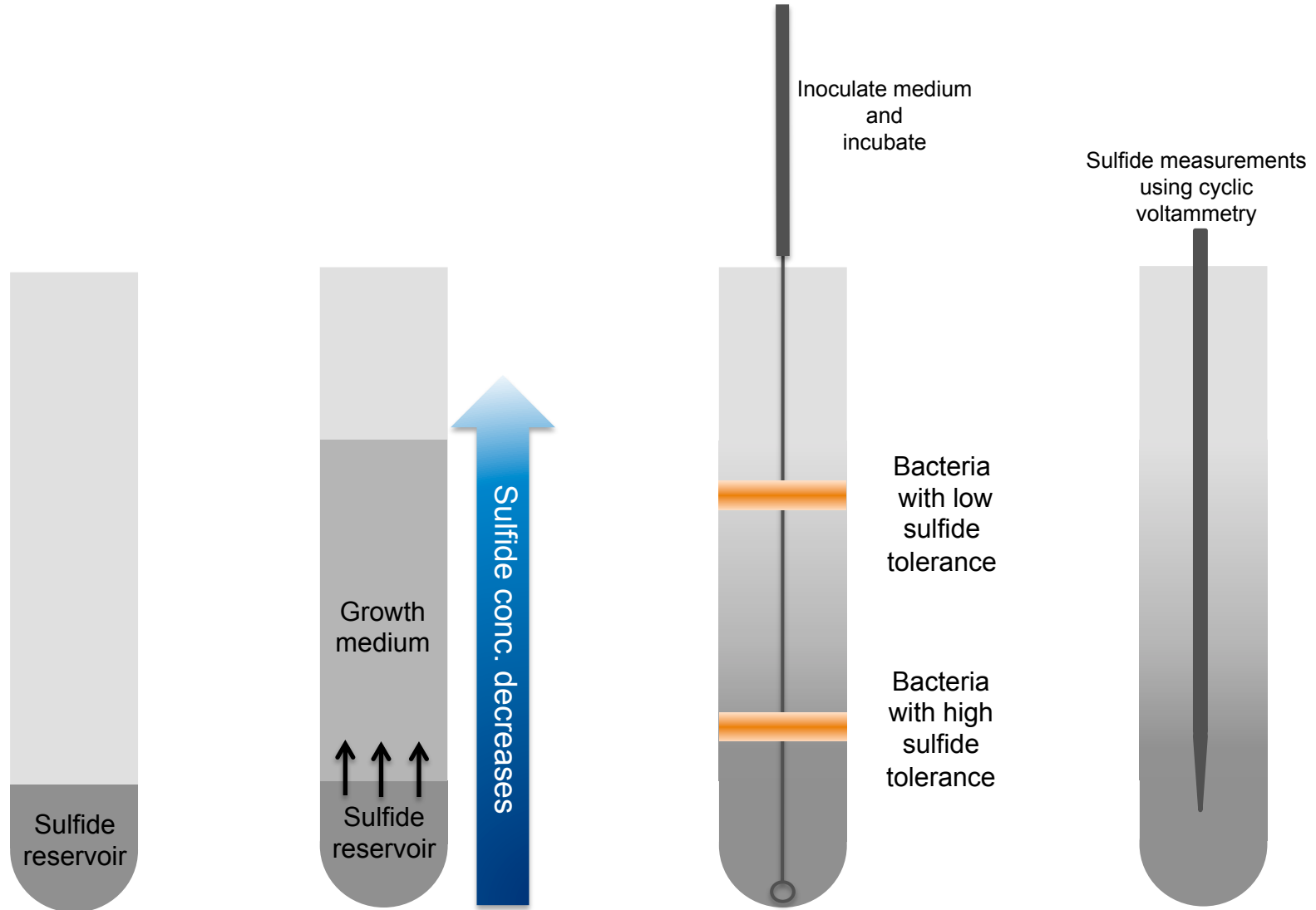
Sulfide-oxidizing Epsilon- and Gammaproteobacteria are adapted to different sulfide concentrations.

We decided to test this hypothesis experimentally

Integration of physiological, molecular and geochemical approaches in environmental microbiology

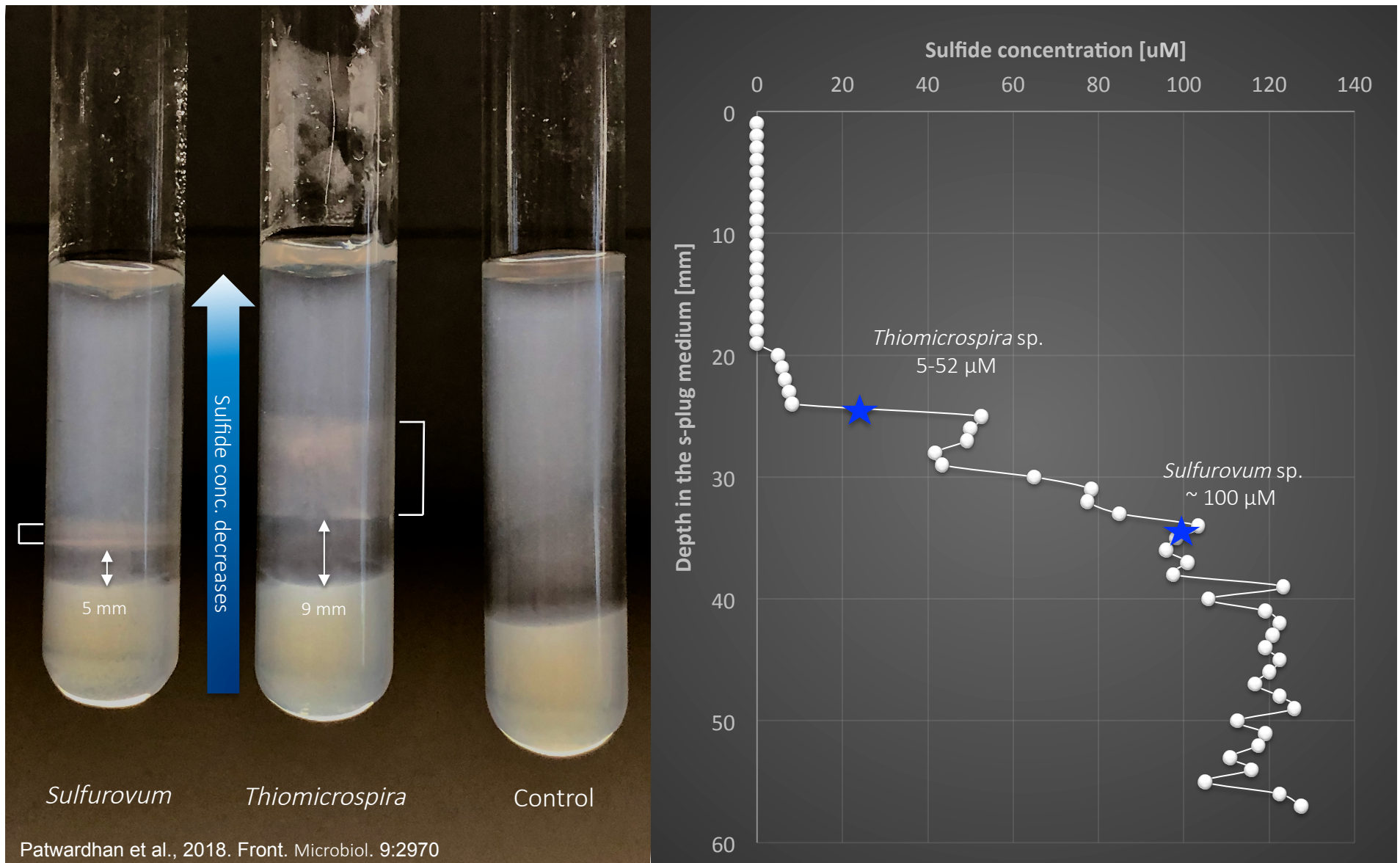


Experimental set-up for testing the adaptation to different sulfide concentrations



Niche partitioning of *Sulfurovum* and *Thiomicrospira* spp. based on sulfide concentration

In situ measurements indicated ranges of 0 – 100 μM (Gammas) and 100- 750 μM (Epsilons)



Assess the metabolic potential (metagenome) of the established and young bacterial filamentous biofilms

In situ collection and preservation of the natural community



Metagenomics

Total community
Over 10M reads/sample

Community genomic DNA extraction

Library preparation and addition of adapter sequences

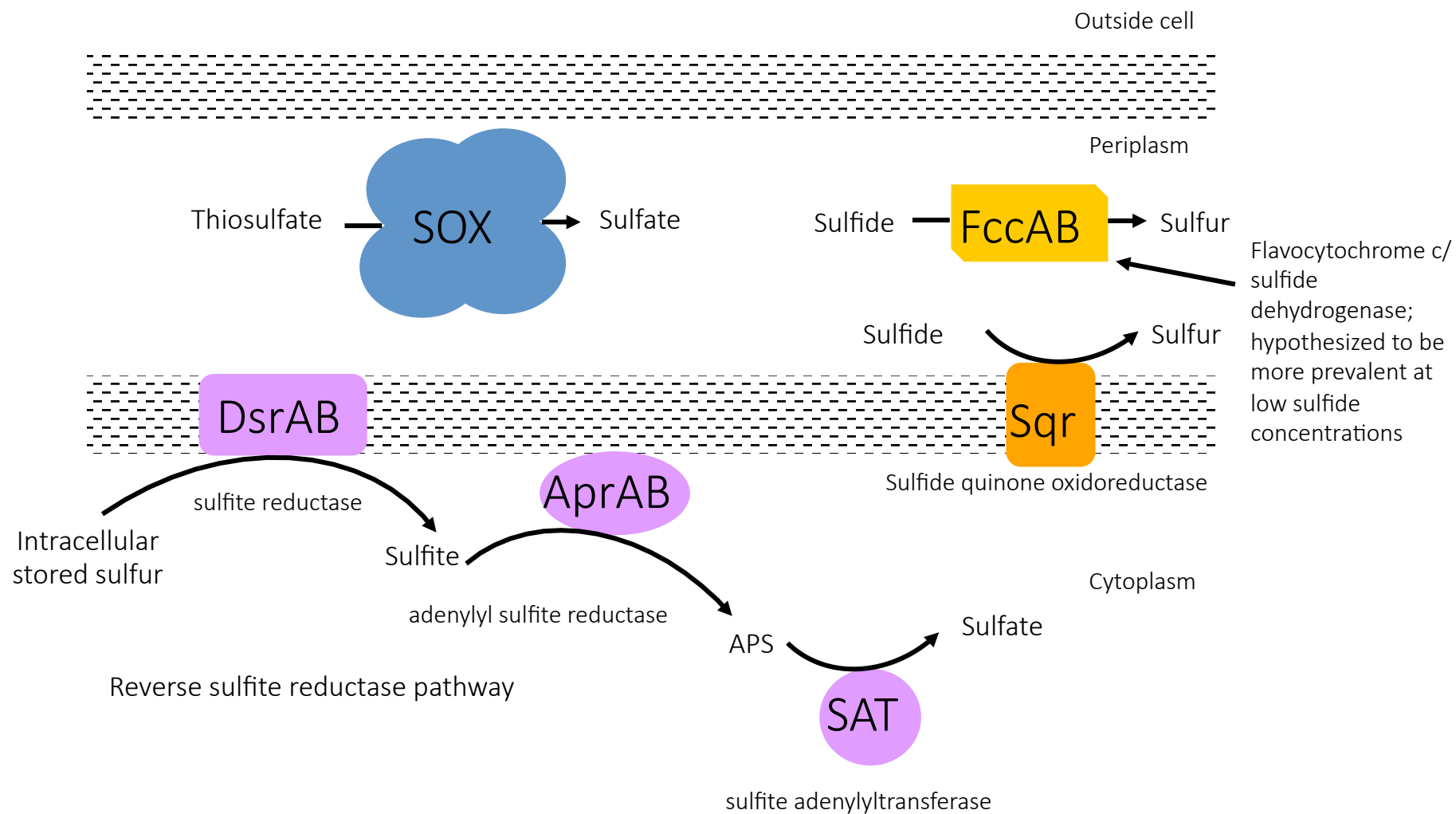
Parallel sequencing of community DNA on HiSeq platform (Illumina)

Sequence data

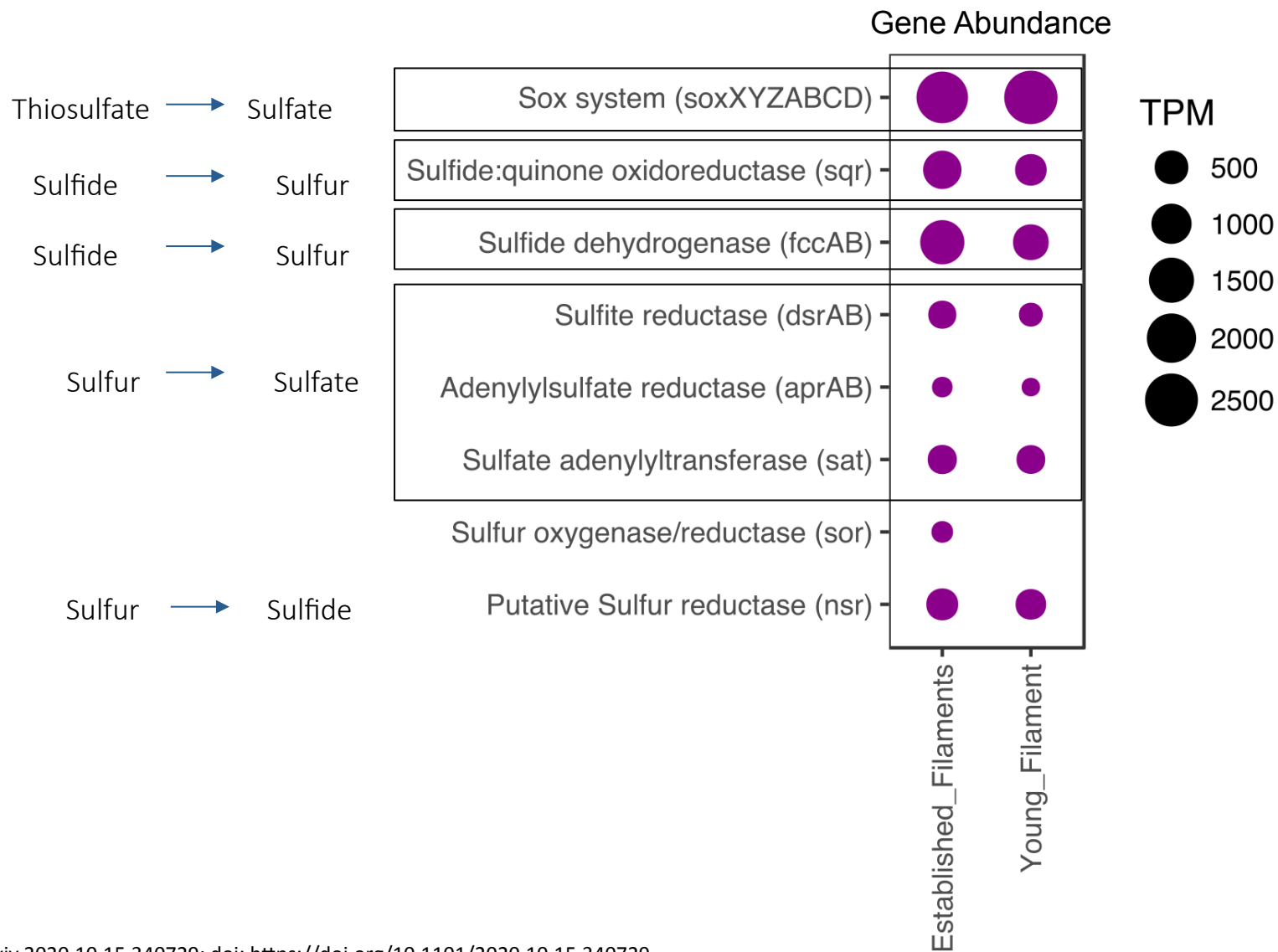
Assembly (Megahit) and annotation (IMG)

Metabolic potential

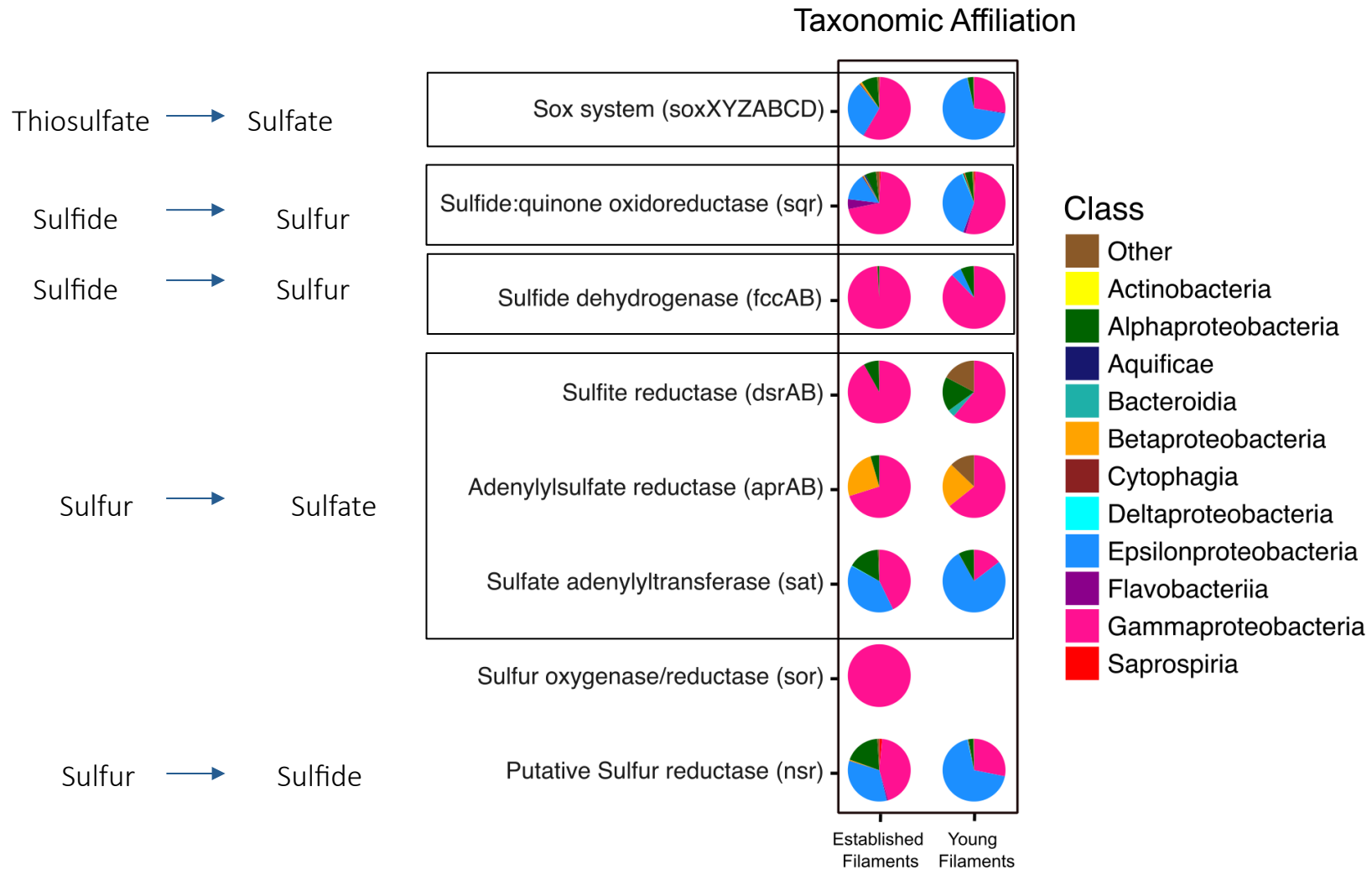
Sulfur oxidation pathways in prokaryotes



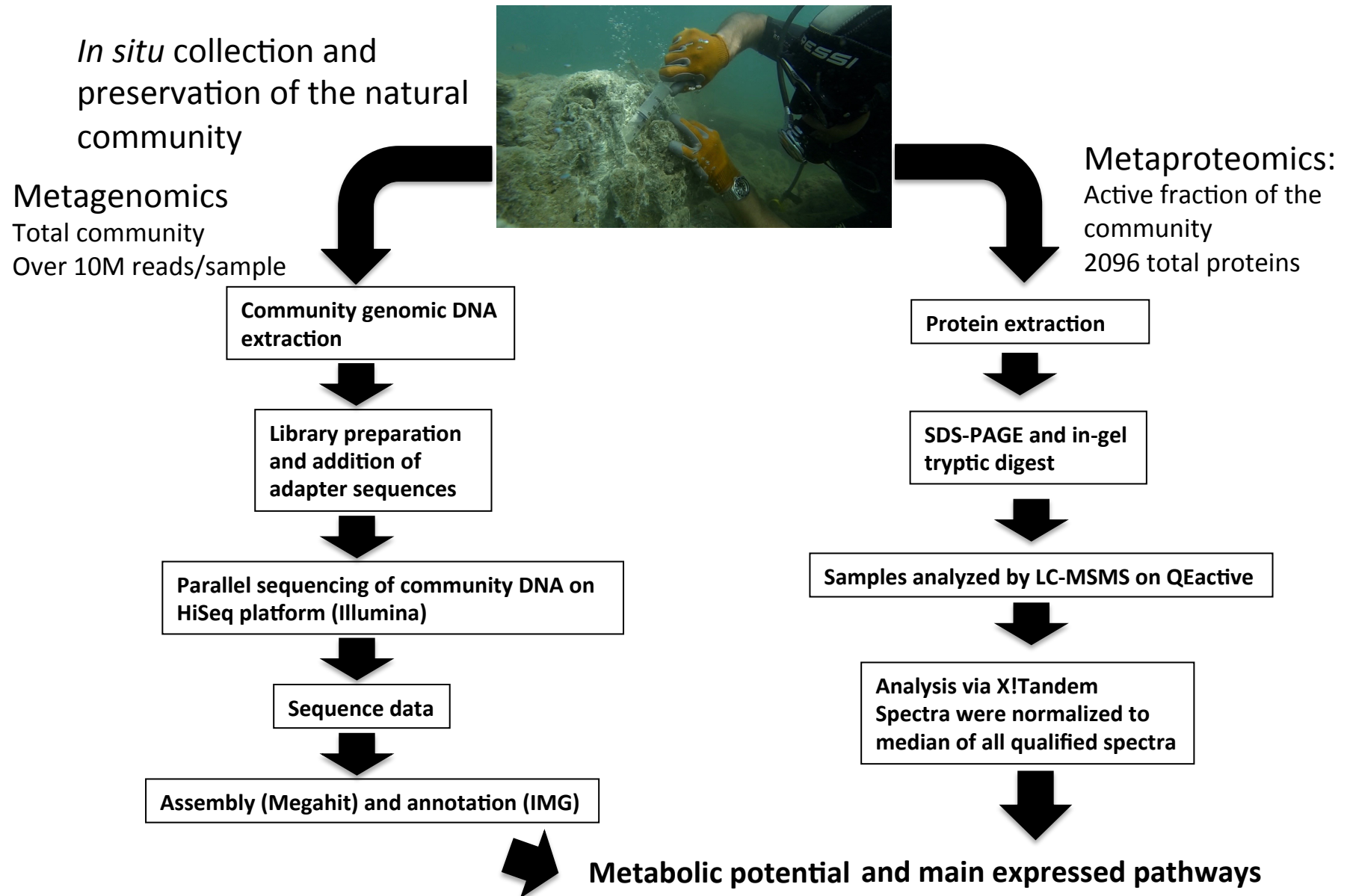
Metagenomic profiling: Potential for using a variety of reduced sulfur compounds as electron donors



Metagenomic profiling: Taxonomic affiliations of sulfide oxidation-related genes

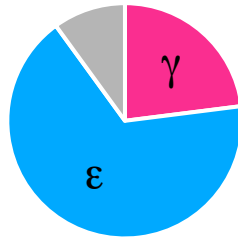


Assess the expressed proteins (metaproteome) of the established and young bacterial filamentous biofilms

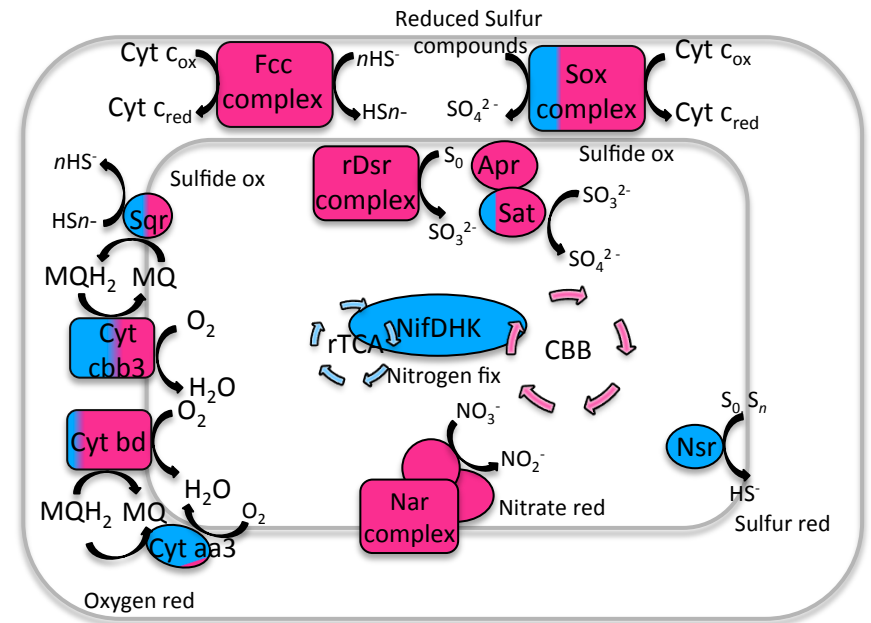
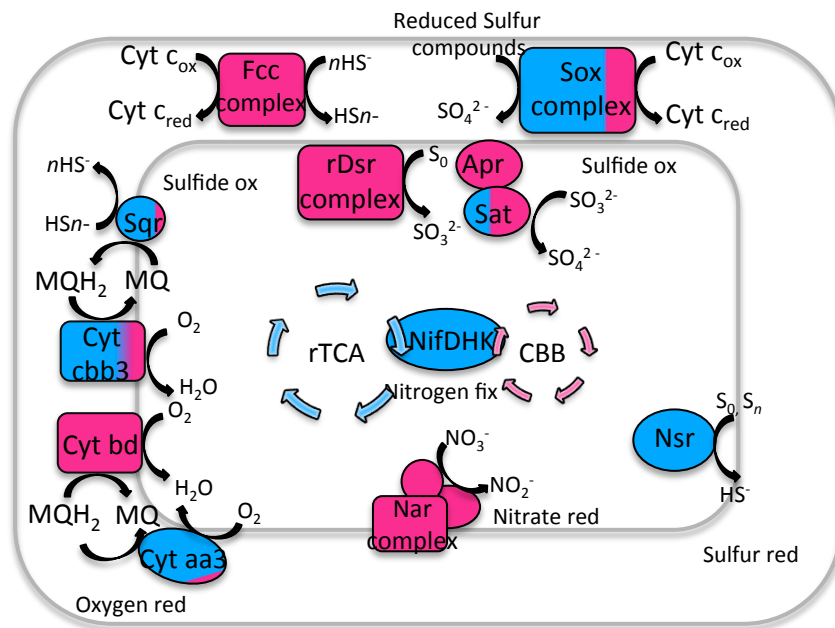
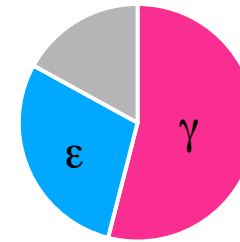


Ecophysiological model of filamentous biofilms during colonization (metaproteome-based)

Young biofilm



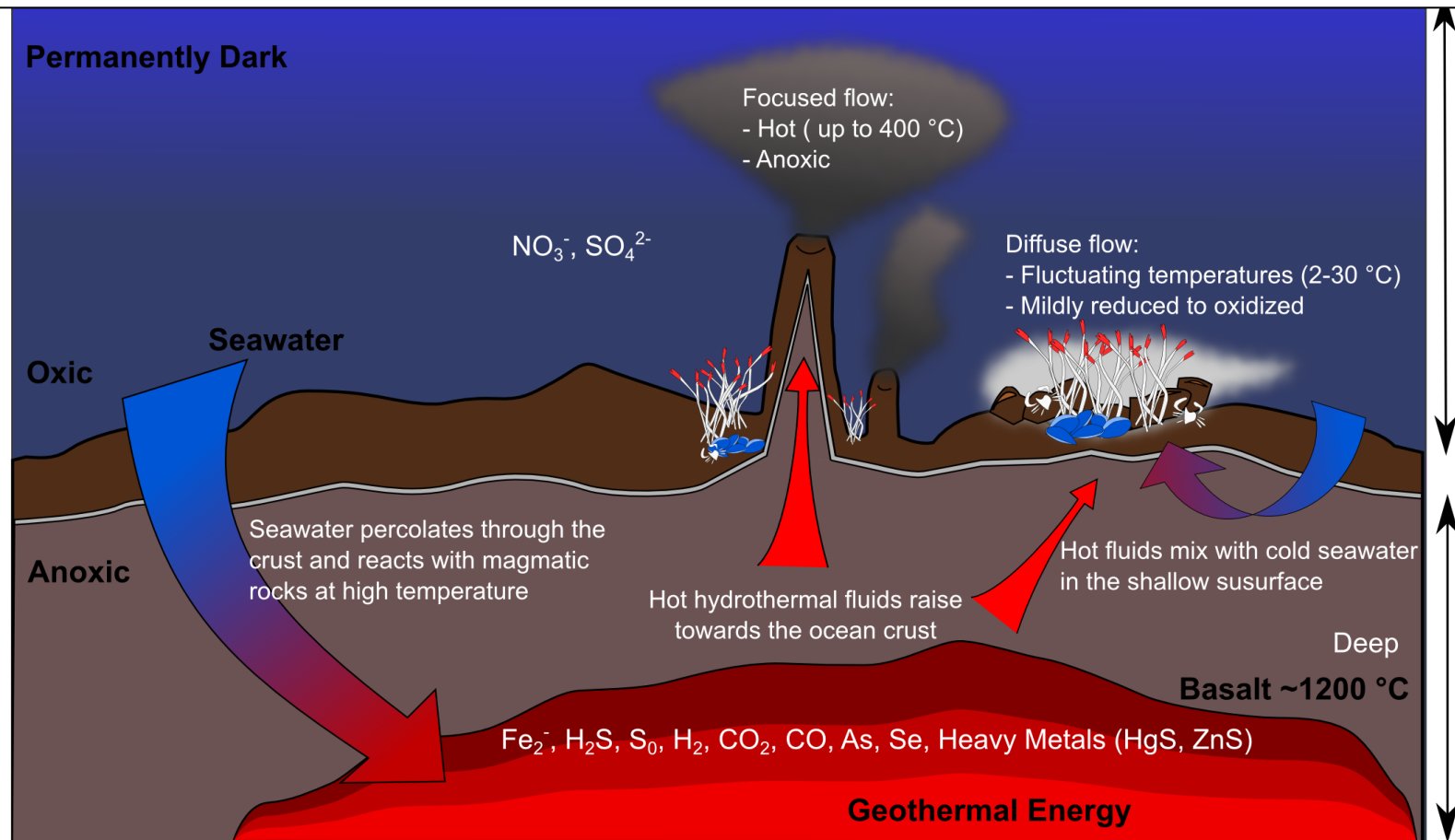
Established biofilm



Days

Weeks

- Chemosynthetic, sulfur-oxidizing Epsilonproteobacteria dominate the active fraction of the biofilm communities in marine hydrothermal systems at H_2S concentrations up to $750 \mu\text{M}$. The oxidize reduced sulfur species via the Sox and Sqr pathways.
- Chemosynthetic, sulfur-oxidizing Gammaproteobacteria dominate the active fraction of the biofilm communities in marine hydrothermal systems at H_2S concentrations up to $100 \mu\text{M}$. The oxidize reduced sulfur species via the Apr, Fcc, Sox and Sqr pathways.
- Epsilonproteobacteria fix CO_2 in situ via the reductive TCA cycle, Gammaproteobacteria use the CBB cycle. Measurements of rates of carbon fixation in laboratory strains and in situ are consistent.

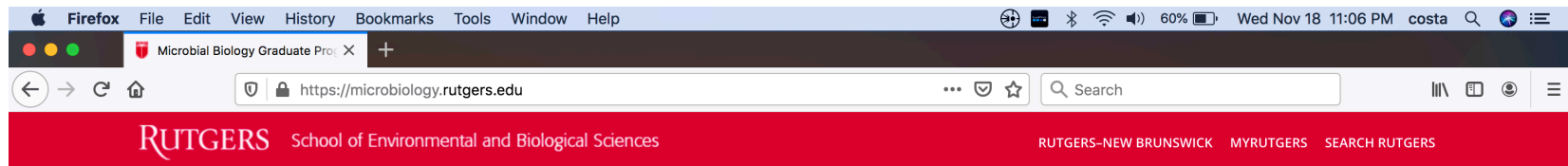


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About the Program

The Microbial Biology Graduate Program at Rutgers University offers a diverse research and educational experience focused on microbial life processes and their applications. You have the opportunity to study the genetic, metabolic, physiologic, and evolutionary diversity of microbes and explore the complex roles that microorganisms play in life on Earth. Rutgers has a rich tradition of microbiology for over a century, starting with research on bovine tuberculosis and soil denitrification in the late 1800s and continuing with the founding of its microbiology department in 1901 and the award of the Nobel Prize to Selman Waksman in 1952.

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