

19 – 22 SETTEMBRE 2024 (19th – 22nd SEPTEMBER, 2024)

Regione Emilia-Romagna, Terza Torre  
Sala 20 maggio 2012, Viale della Fiera 8, Bologna

# CONVEGNO INTERNAZIONALE

INTERNATIONAL CONFERENCE

## AREE CARSICHE NEI GESSI: CONSERVAZIONE, GESTIONE E FRUIZIONE. SFIDE ED OPPORTUNITÀ PER IL PATRIMONIO MONDIALE UNESCO DELL'APPENNINO SETTENTRIONALE

GYPSUM KARST AREAS: CONSERVATION, MANAGEMENT AND PUBLIC USE. CHALLENGES  
AND OPPORTUNITIES FOR THE NORTHERN APENNINE UNESCO WORLD HERITAGE SITE

Prof.ssa Martina Cappelletti

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Studio della microbiologia delle grotte di gesso per valutare la salute dell'ecosistema e guidare le strategie di conservazione/ **The study of microorganisms inhabiting gypsum caves to assess the ecosystem health and to guide preservation strategies**

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# Studio della microbiologia delle grotte di gesso per valutare la salute dell'ecosistema e guidare le strategie di conservazione

*The study of microorganisms inhabiting gypsum caves to assess the ecosystem health and to guide preservation strategies*

Martina Cappelletti

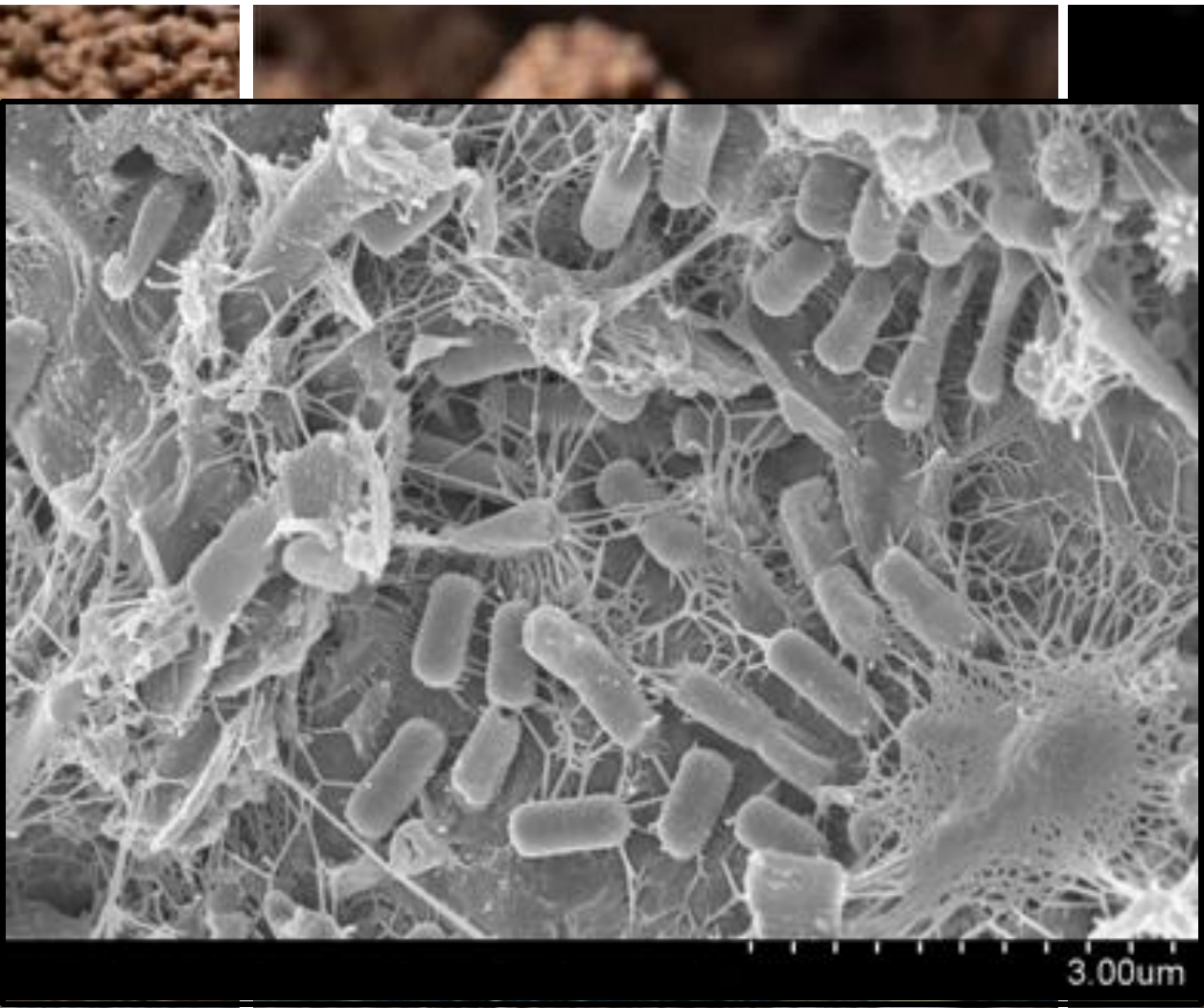
Molecular Environmental Microbiology Lab (MEMlab), University of Bologna

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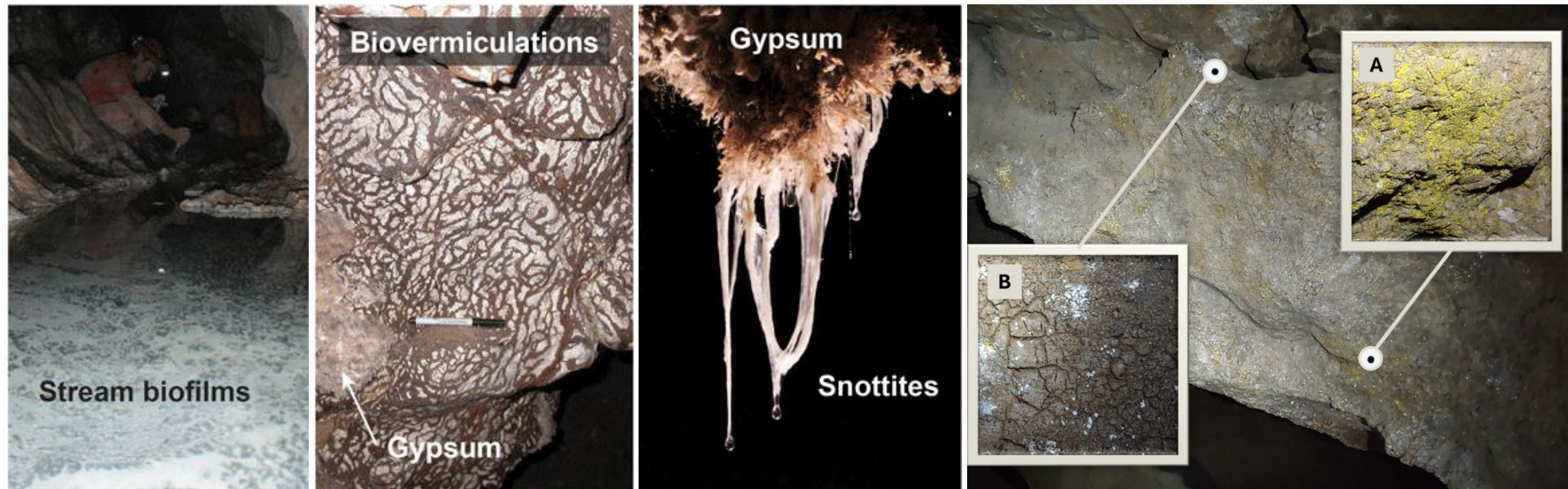




> 95% of cave bioiversity is MICROBIAL



# How do we see the microbial life in caves?



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# The significance of microorganisms in subterranean environments

- Interaction between microbes and rock substrate  
→ *dissolution and speleothems*



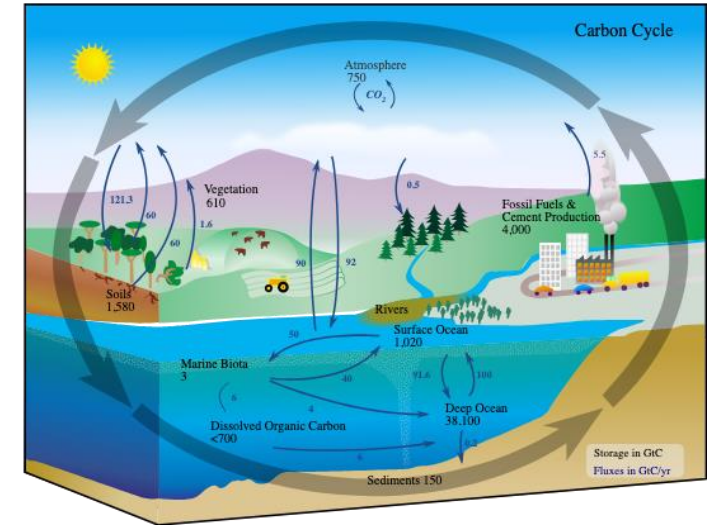
Tomczyk-Žak et al. (2015). *Geomicrob J*



Cappelletti et al. *Unpublished*

# The significance of microorganisms in subterranean environments

- Interaction between microbes and rock substrate → *dissolution and speleothems*
- Biogeochemical cycles and nutrients → *trophic interactions*



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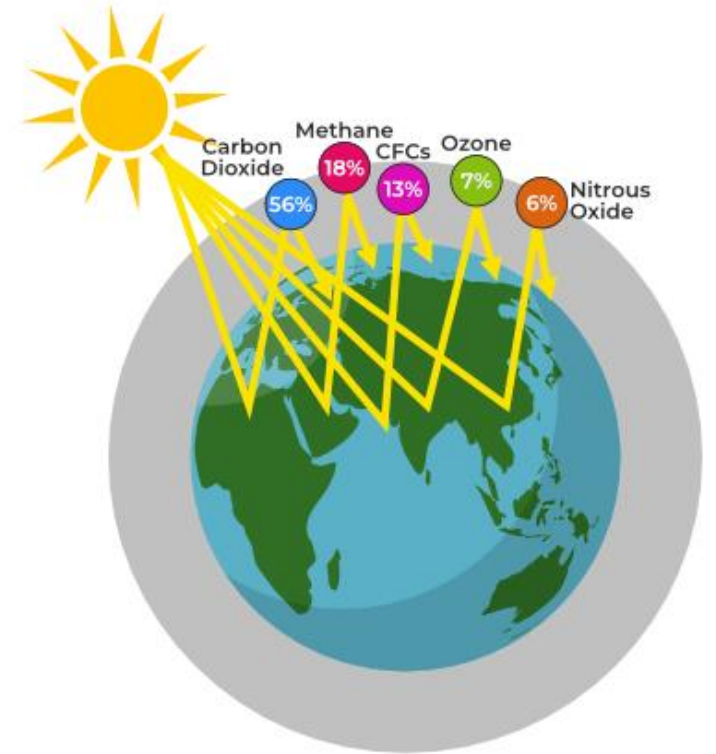
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Microrganismi come fonti nutritive per

# The significance of microorganisms in subterranean environments

- Interaction between microbes and rock substrate → dissolution and speleothems
- Biogeochemical cycles and nutrients → *trophic interactions*
- Assimilation/consumption of greenhouse gases → *methane oxidation, CO<sub>2</sub> assimilation*



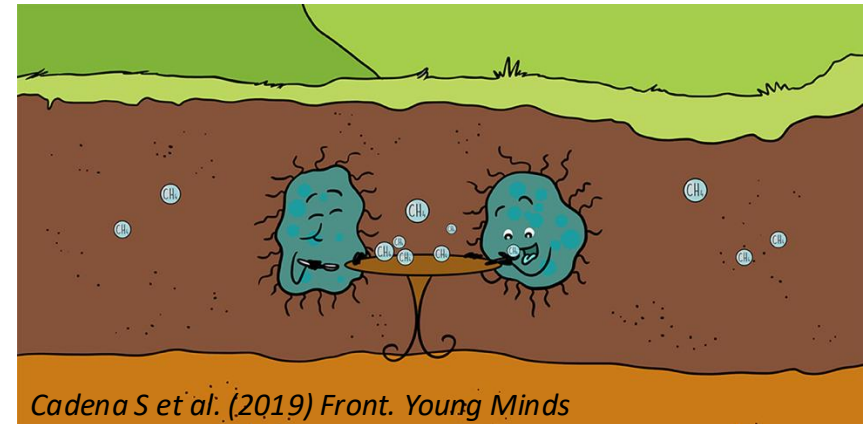
<https://www.geeksforgeeks.org/what-is-the-greenhouse-effect/>

# The significance of microorganisms in subterranean environments

- Interaction between microbes and rock substrate → *dissolution and speleothems*
- Biogeochemical cycles and nutrients → *trophic interactions*
- Assimilation/consumption of greenhouse gases → *methane oxidation, CO<sub>2</sub> assimilation*
- Metabolism of contaminants → *biodegradation, metal transformation*



Wind Cave National Park



Cadena S et al. (2019) Front. Young Minds

Microbial biodiversity is strictly connected not only with the ecosystem health (and resilience) but also with human health  
*(One Health framework)*

## The One Health Triad



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# Antropic impact on microbial diversity in caves



Turismo/visitatori



Attività estrattive



Specie aliene e patogeni



Inquinamento



Utilizzo del suolo



Cambiamento climatico

# What is known about microbes and gypsum caves?

Science of the Total Environment 598 (2017) 538–552

Contents lists available at ScienceDirect

**Science of the Total Environment**

journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)

ELSEVIER

Geochemistry and microbial diversity of cave waters in the gypsum karst aquifers of Emilia Romagna region, Italy

Ilenia M. D'Angeli<sup>a</sup>, Diana I. Serrazanetti<sup>b</sup>, Chiara Montanari<sup>b</sup>, Lucia Vannini<sup>b,c</sup>, Fausto Gardini<sup>b,c</sup>, Jo De Waele<sup>a,\*</sup>

CrossMark

Microbial Ecology (2024) 87:80  
<https://doi.org/10.1007/s00248-024-02395-y>

RESEARCH

Check for updates

**Gypsum Cave Biofilm Communities are Strongly Influenced by Bat- And Arthropod-Related Fungi**

Valme Jurado<sup>1</sup> · Tamara Martin-Pozas<sup>2</sup> · Angel Fernandez-Cortes<sup>2</sup> · Jose Maria Calaforra<sup>2</sup> · Sergio Sanchez-Moral<sup>3</sup> · Cesareo Saiz-Jimenez<sup>1</sup>

- **Nitrates** and **ammonium** influence **coliform** bacteria (in waters)
- Possible effect of the **season** and **bat guano** on coliform bacteria
- **Bat guano** influences **fungal** population in a gypsum cave in Spain

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# Project “Microbiological study of gypsum caves in Emilia Romagna”

(in collaboration with Federazione Regionale Speleologica dell’Emilia Romagna)

## PROJECT AIMS

To define:

- **Biodiversity** and **microbial functions** present in the gypsum caves
- **Environmental factors** driving biodiversity and microbial functions
- Presence of bacteria associated with **biogeochemical cycles, atmospheric gases, trophic networks**
- Presence of bacteria interacting with the **rock substrate**

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# Experimental approaches

## Analisi basate sul DNA



DNA extraction



DNA sequencing



Description of the  
microorganisms



## Analisi dei microrganismi isolati



Microbial isolation

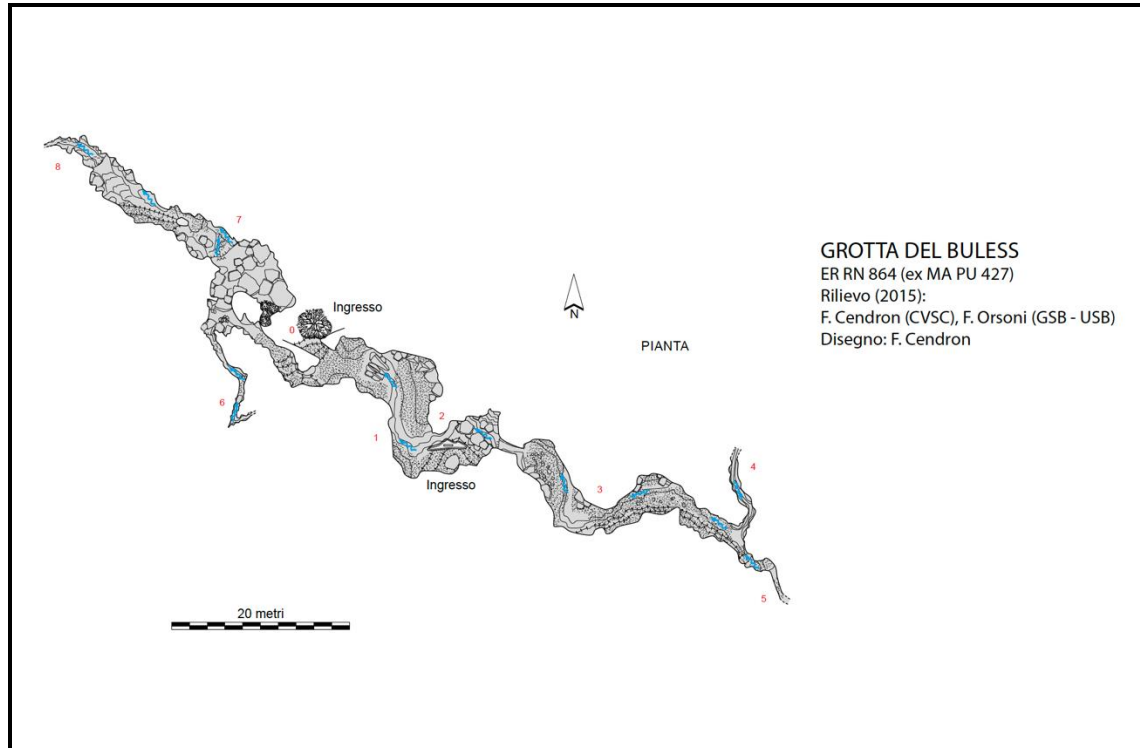


Metabolic assays in the lab

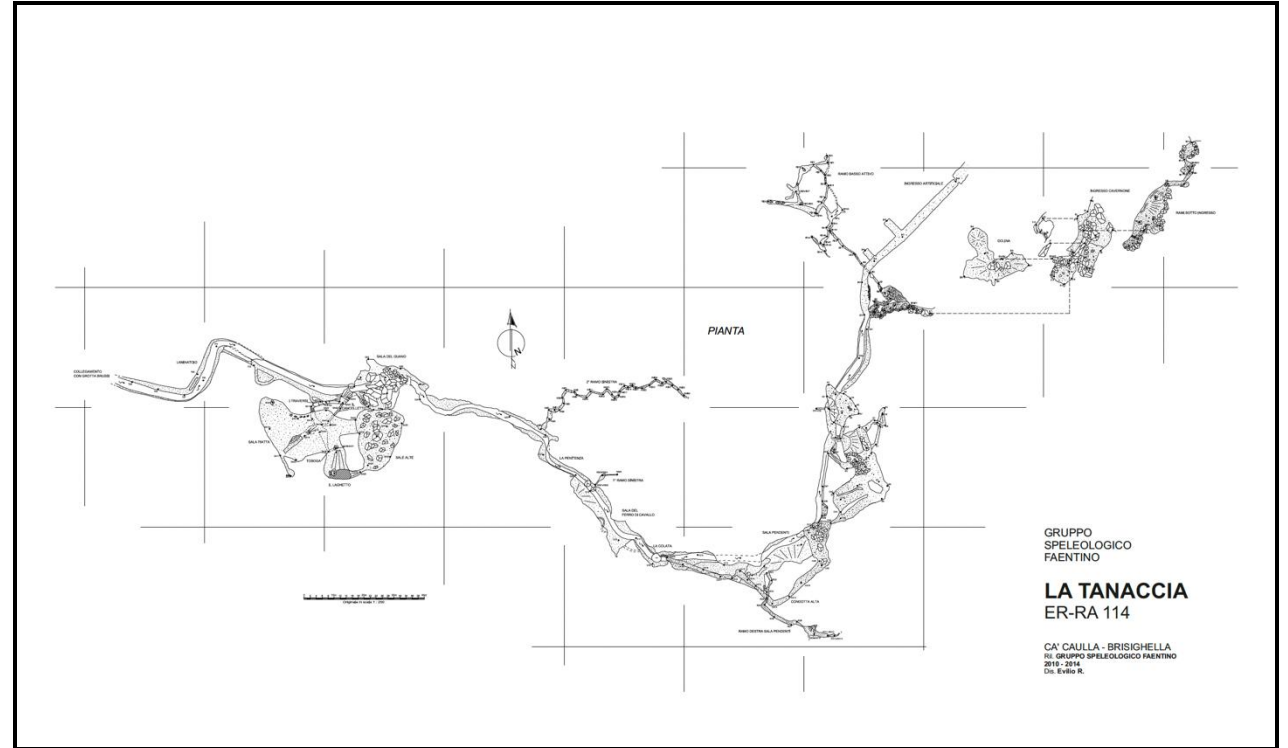


Identifying microbes with  
interesting activities

# Caves analysed up to date



- In gypsum area in Eastern Romagna
- Hypogenic sulfuric springs



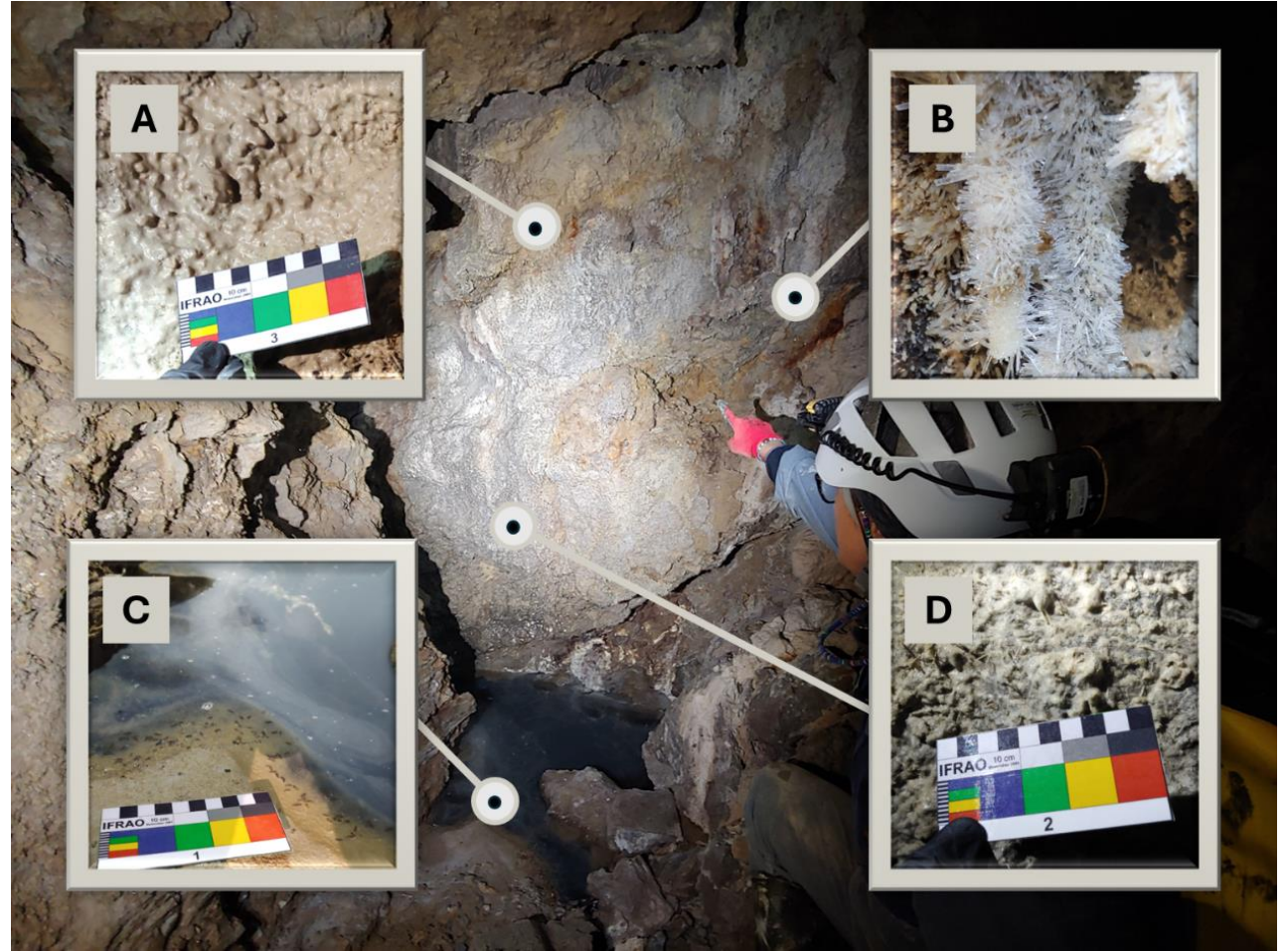
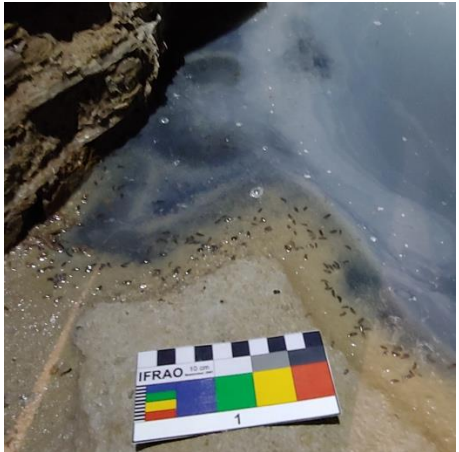
- Inside Parco della Vena del Gesso
- Representative of typical gypsum cave

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# Sampling in the Bules cave

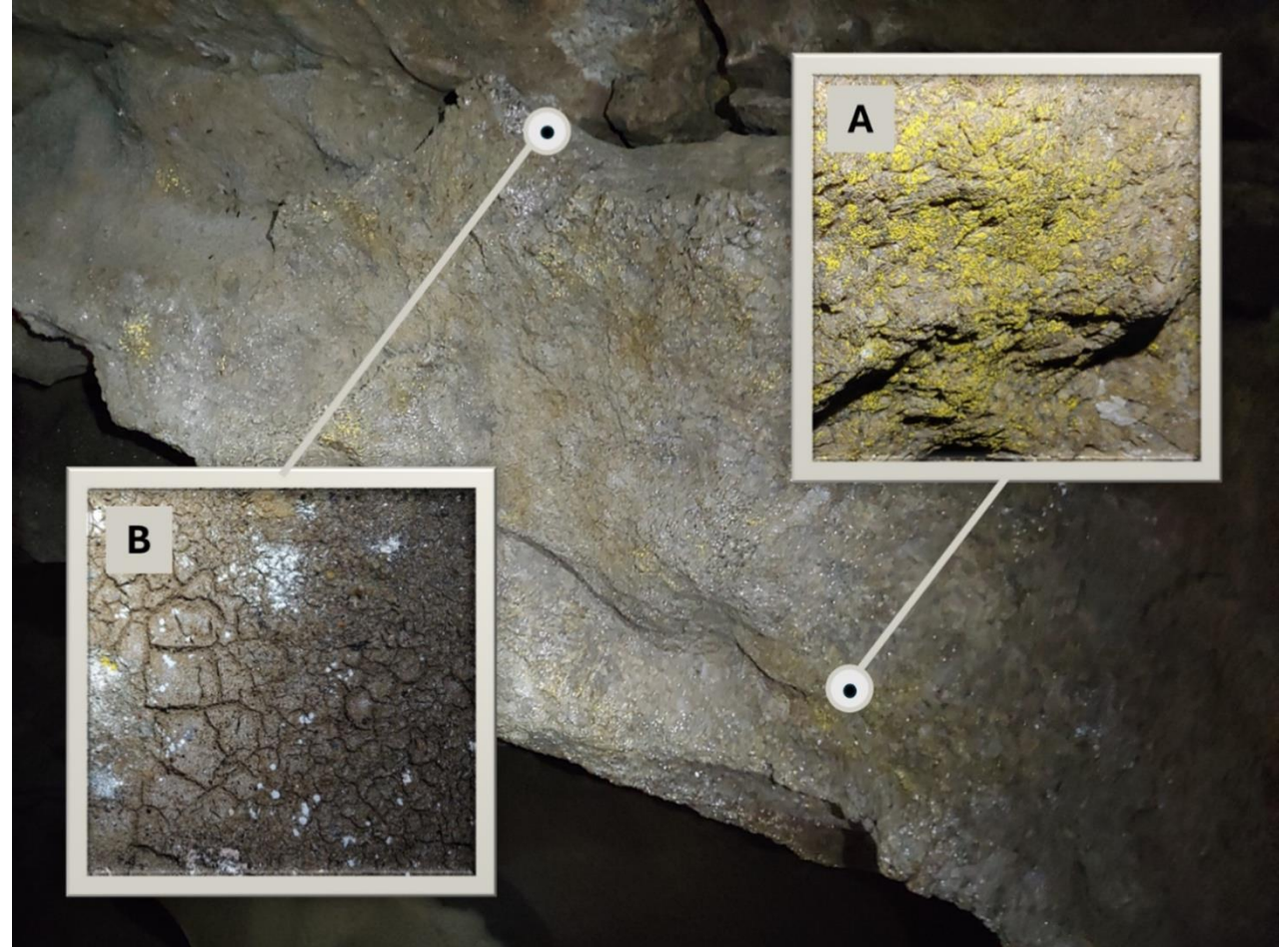


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# Sampling in the Tanaccia cave

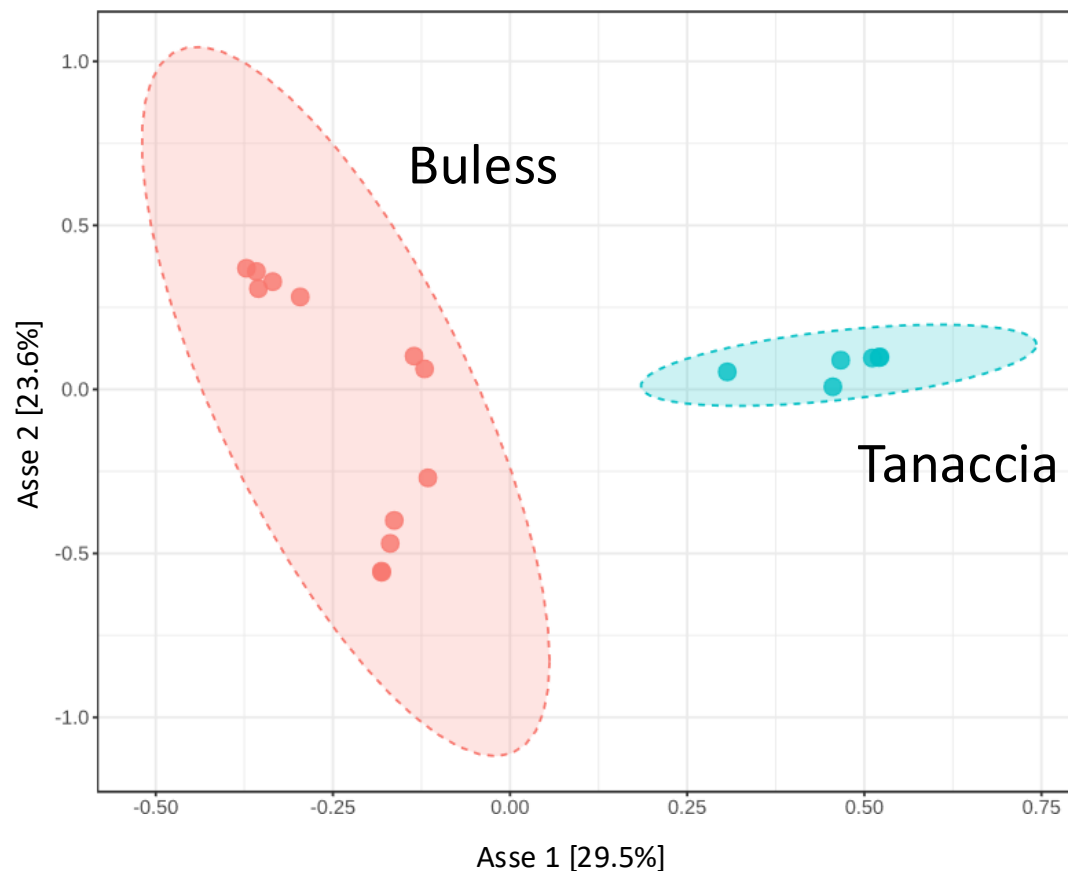


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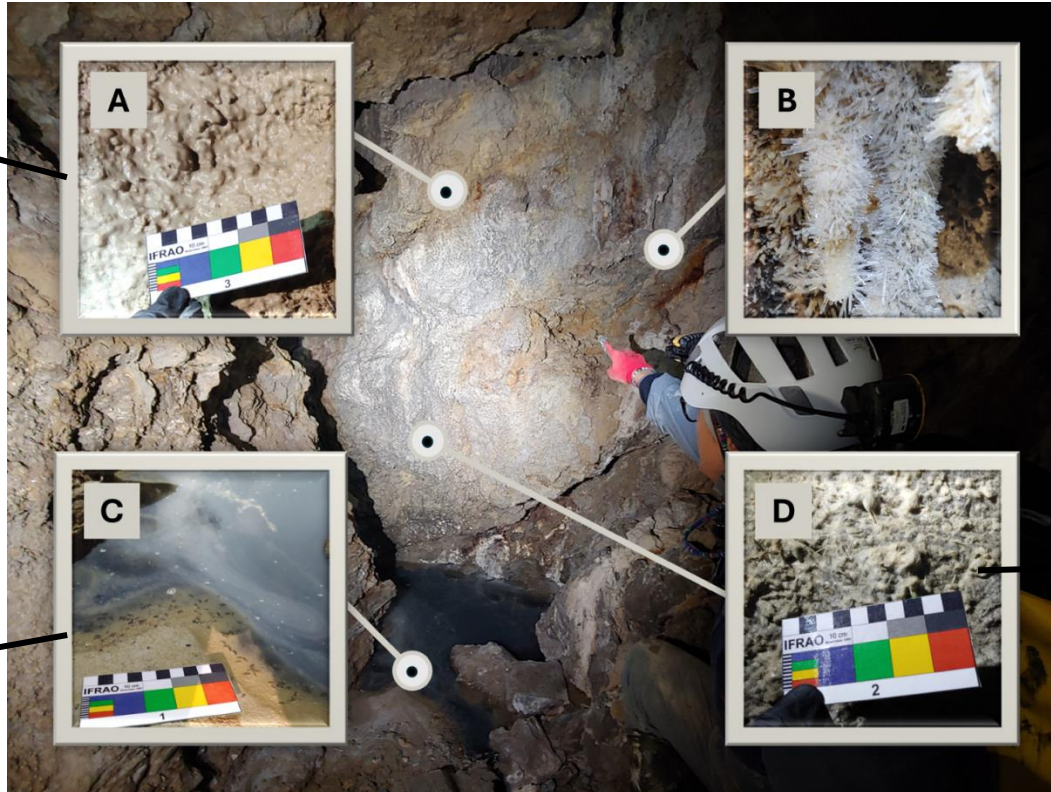
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# Microbial biodiversity in the two caves



# Microorganisms in the Buless cave

- *Acidithiobacillus*
- *Bacillus*
- *Metallibacterium*
- *Staphylococcus*



- *Metallibacterium*
- *Sulfuriferula*
- *Thiobacillus*
- *Sulfurifustis*
- *Thiomonas*

- *Desulfucapsa*
- *Geobacter*
- *Sulfurimonas*
- *Sulfurovum*

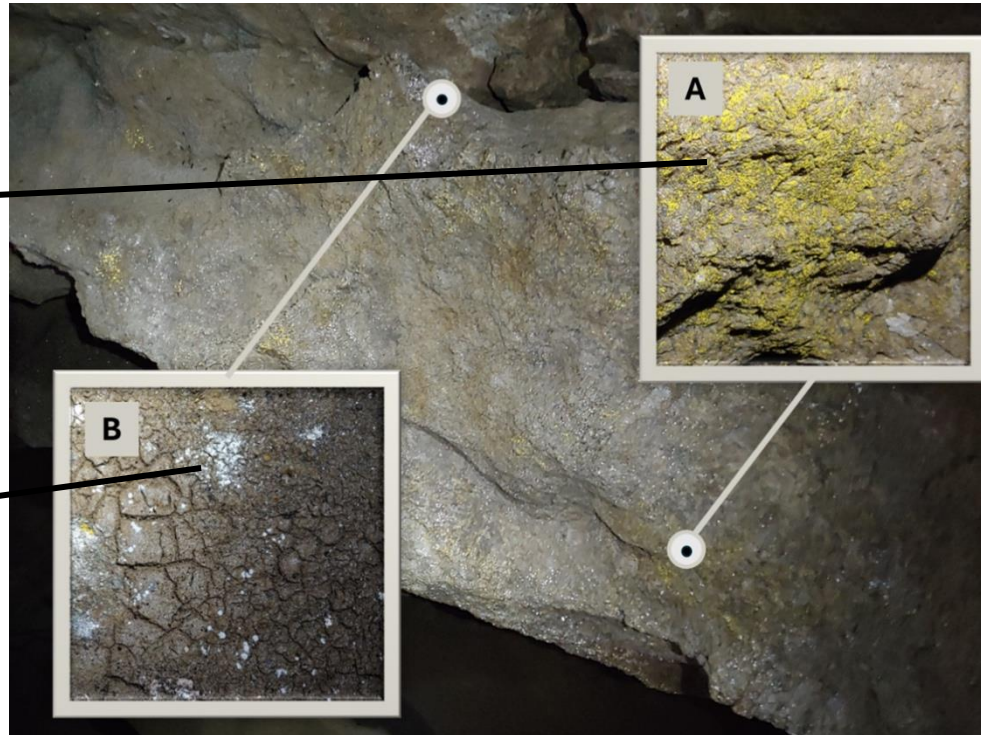
- *Metallibacterium*

Biodiversity is shaped by H<sub>2</sub>S-rich rising fluids

→ Bacteria involved in *sulfur cycle* and *metal oxidation*, *human/animal associated bacteria* in a few samples

# Microorganisms in the Tanaccia cave

- *Crossiella*
- *Xanthomonadaceae*
- *Nitrosococcaceae*
- *Rhizobiales*



- *Nitrosococcaceae*
- *Nitrosomonadaceae*
- *Methyloligellaceae*

- *Crossiella*
- *Streptomyces*
- *Gaiella*
- *Methyloligellaceae*



- *Beijerinckiaceae*
- *Burkholderiales*
- *Methyloligellaceae*
- *Nitrosomonadaceae*

Biodiversity shaped by oligotrophy (low nutrients)

→ Bacteria involved in *methane oxidation*, *CO<sub>2</sub> assimilation*, *N cycle*, *biomineralization*

# Conclusioni e prospettive future

- Great difference in the **microbial biodiversity** between the two caves → *environmental factors*
- Bacterial functions associated with **biogeochemical cycles** in caves and **interaction with the rock substrate** → *possible key role in ecosystem health*
- A few bacteria associated with humans/animals in one cave (to be further analysed)

*in progress*: **extend the analysis** to other caves (water, sediments, biofilm) and **correlation studies** with geochemical data → *global vision of biodiversity and microbial functions in gypsum caves and possible disturbance factors*

# Ringraziamenti



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Grazie dell'ascolto! / Thanks!

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