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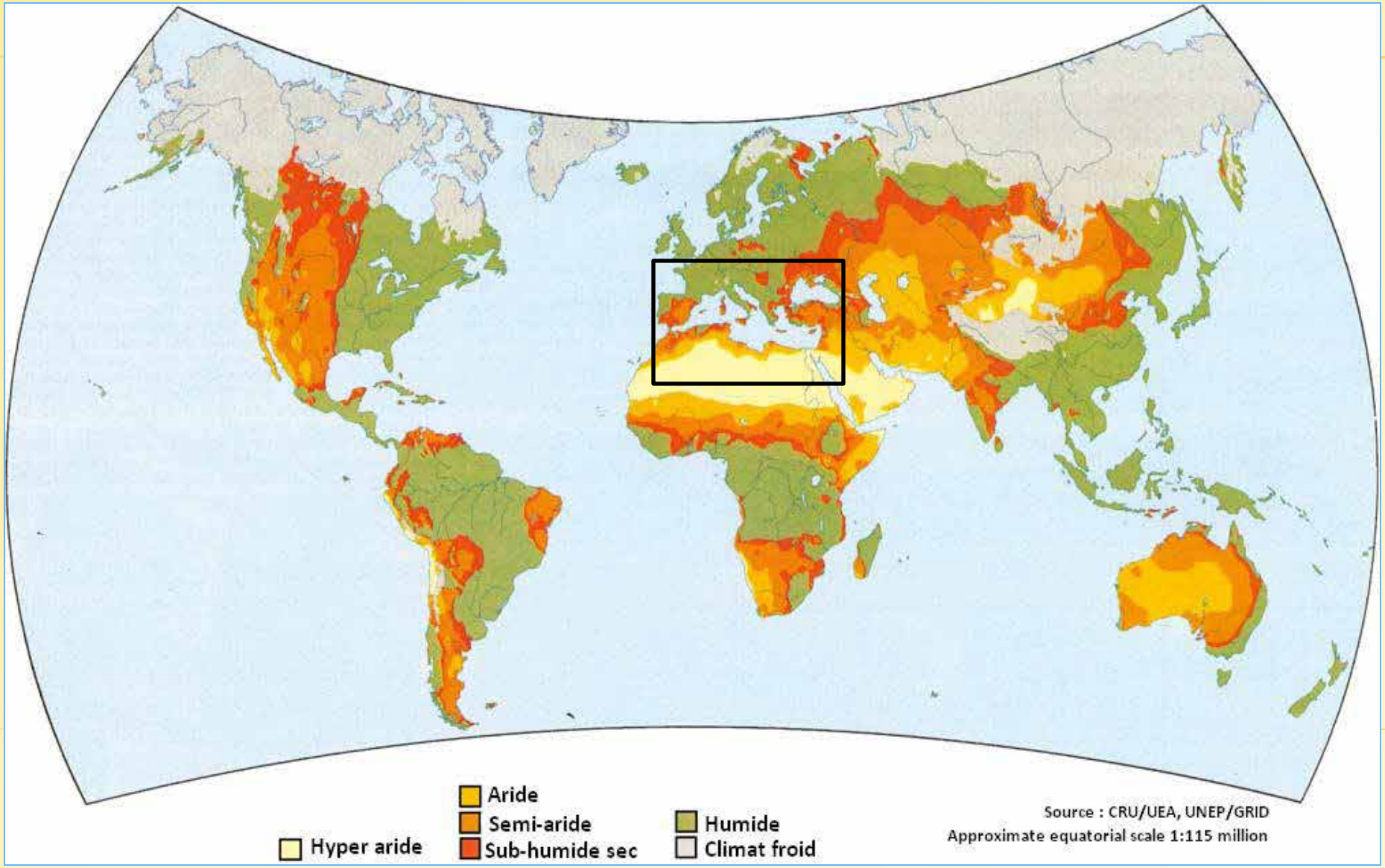
Sandy gypsic biosols : occurrence of sandy Gypsiferous soil microhabitats on the Sahara Desert, North Africa (Algeria): a micromorphological approach

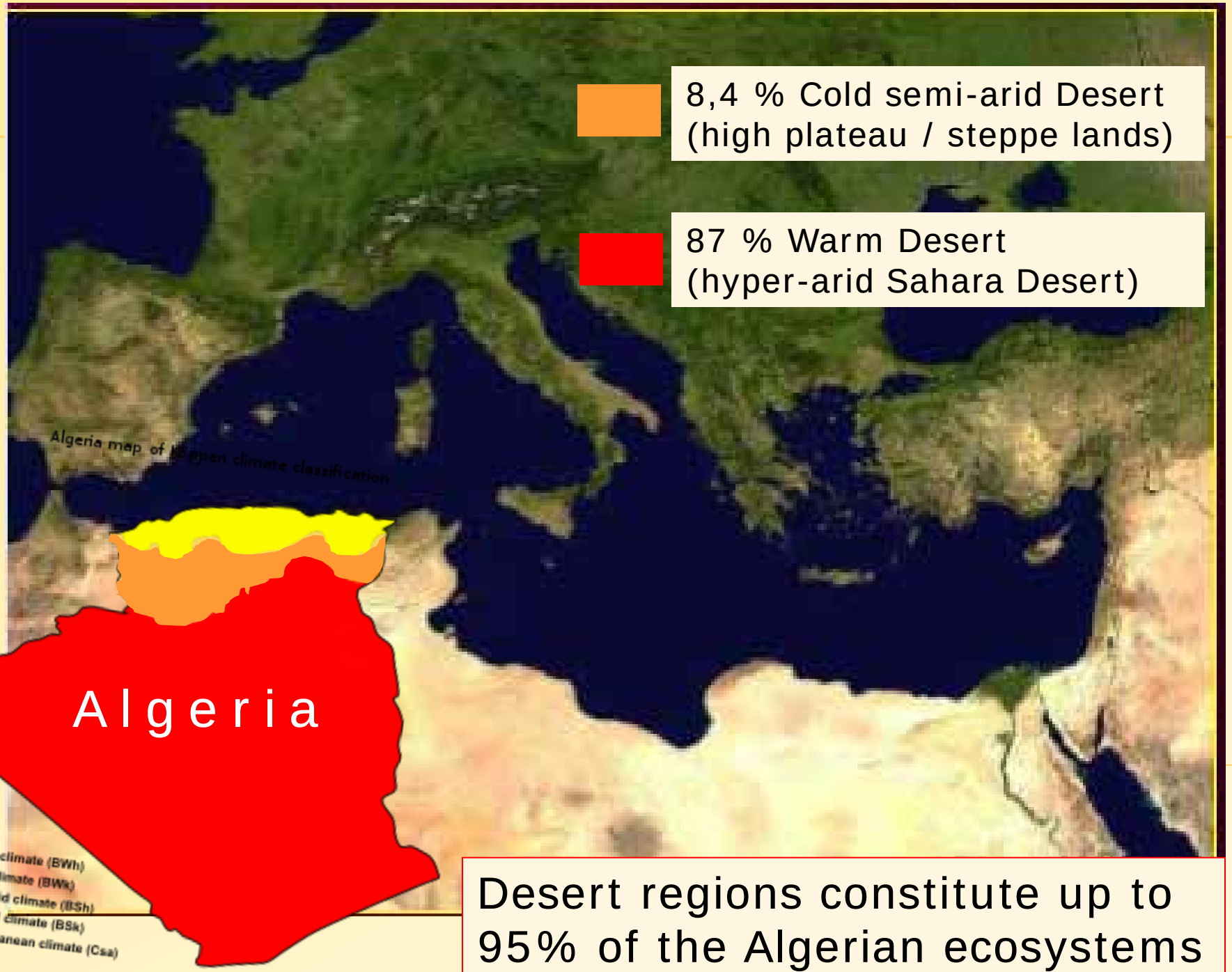
Background

Sandy Gypsiferous soils are among the major soils of arid regions of the world. In the Sahara desert, they occupy large areas, where gypsum accumulations are favored by the polyextreme environment. Various complex gypsic pedofeatures have been recognized and each hosts a striking biological diversity of photoautotrophic communities including Biological soil crusts “Biocrusts” (BSCs).

BSCs play a key role in soil carbon sequestration. They are a viable pathway to contrast desertification and to favor soil rehabilitation in drylands worldwide. However, little is known about the relationship BSCs / soil material, where micromorphological information is extremely scarce especially in the Sahara desert (North Africa).


Aride
Semi-aride
Sub-humide sec
Humide
Hyper aride
Climat froid
Source : CRU/UEA, UNEP/GRID
Approximate equatorial scale 1:115 million


Sahara Desert



Desert regions constitute up to 95% of the Algerian ecosystems

Algerian Desert landscapes


Steppe land

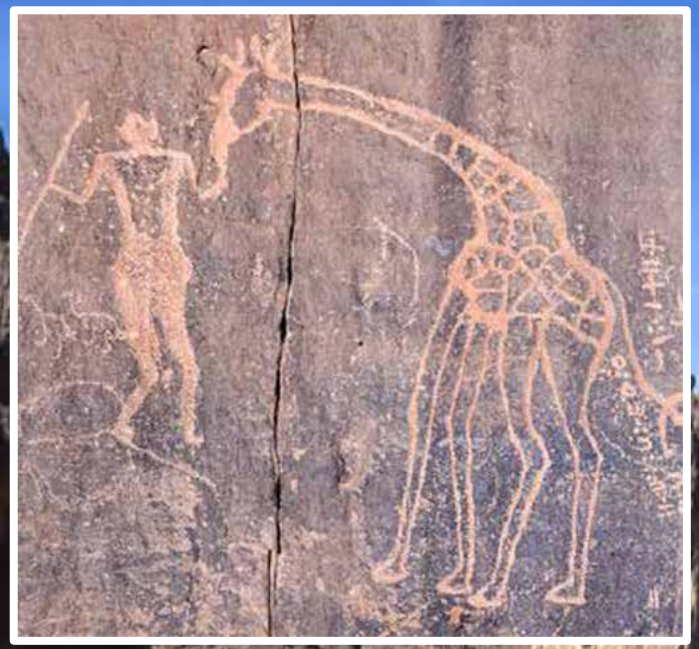
Reg (gravely landscape)


Erg (Sand dunes)

Sabkha (playa landscape)

Wadi (alluvial valley)

Hoggar and Tassili montagnes



Sahara rock art

Hoggar and Tassili montagnes

Livestock

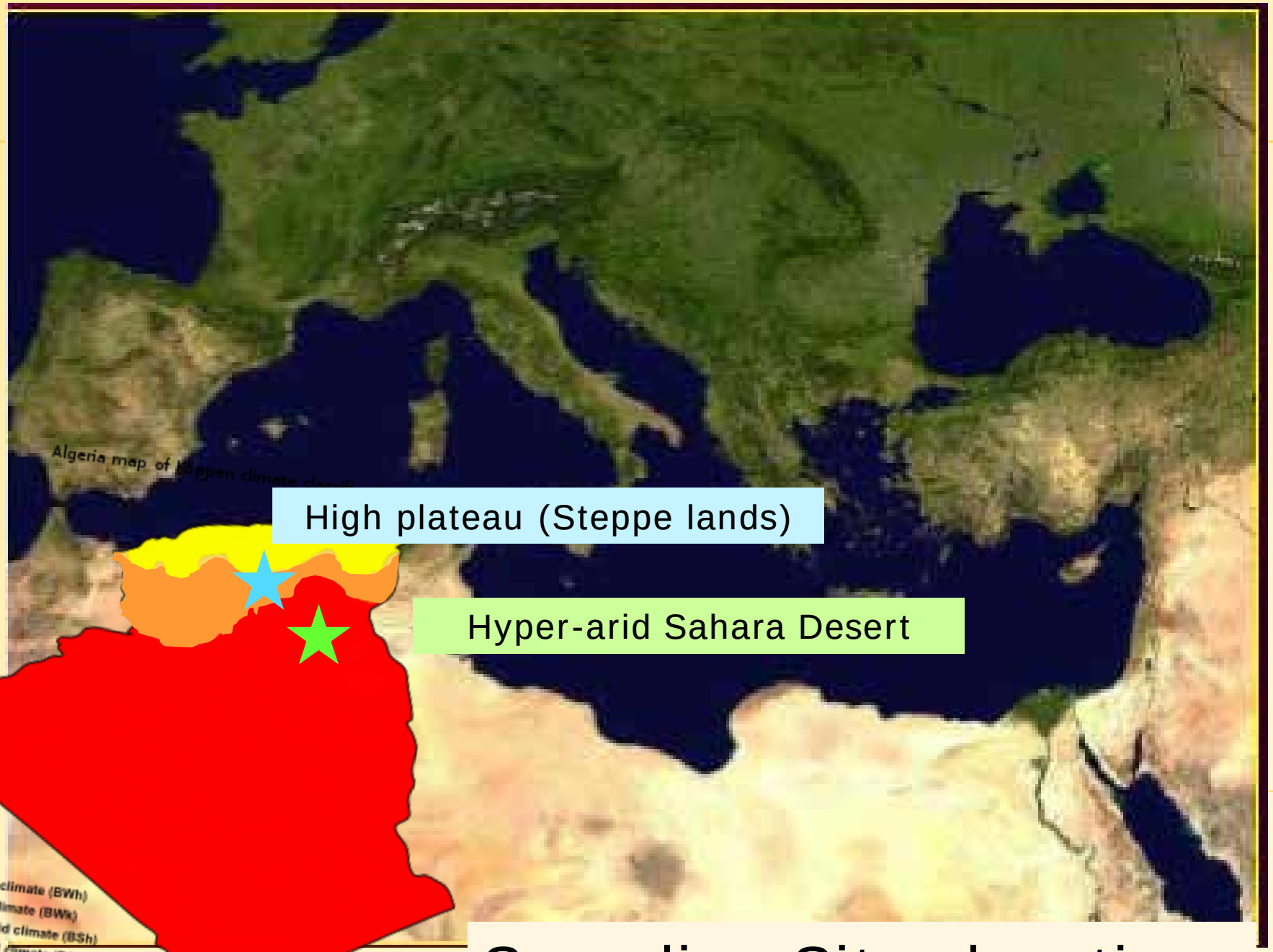

Oasis agrosystem


Modern agrosystem

Objective

In this study, we report the micromorphological approach of the soil microhabitats of endolithic, epilithic and hypolithic Biocrusts (BSCs) growing in some sandy Gypsiferous soils in the Sahara desert.

Material and Methods



Sampling Sites locations


Hassi Bahbah
Sa (Al Mosran)
Al Mosran
Dar Chioukh
Zaafrane
M'Liliha
Djelfa
Image Landsat / Copernicus
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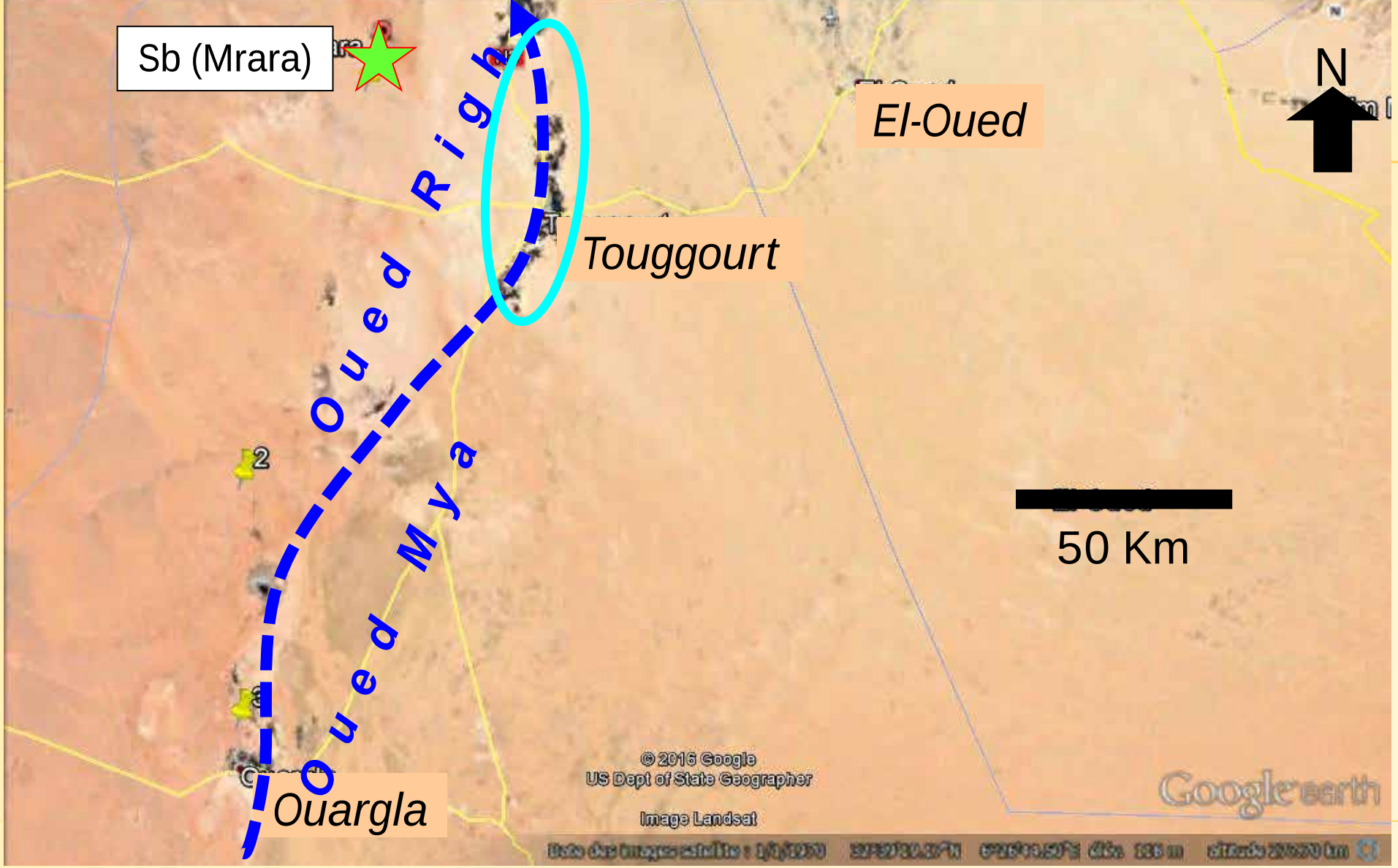
20 Km
High plateau / steppe lands (Cold Desert)

Epilithic BSC



Sampling Sites

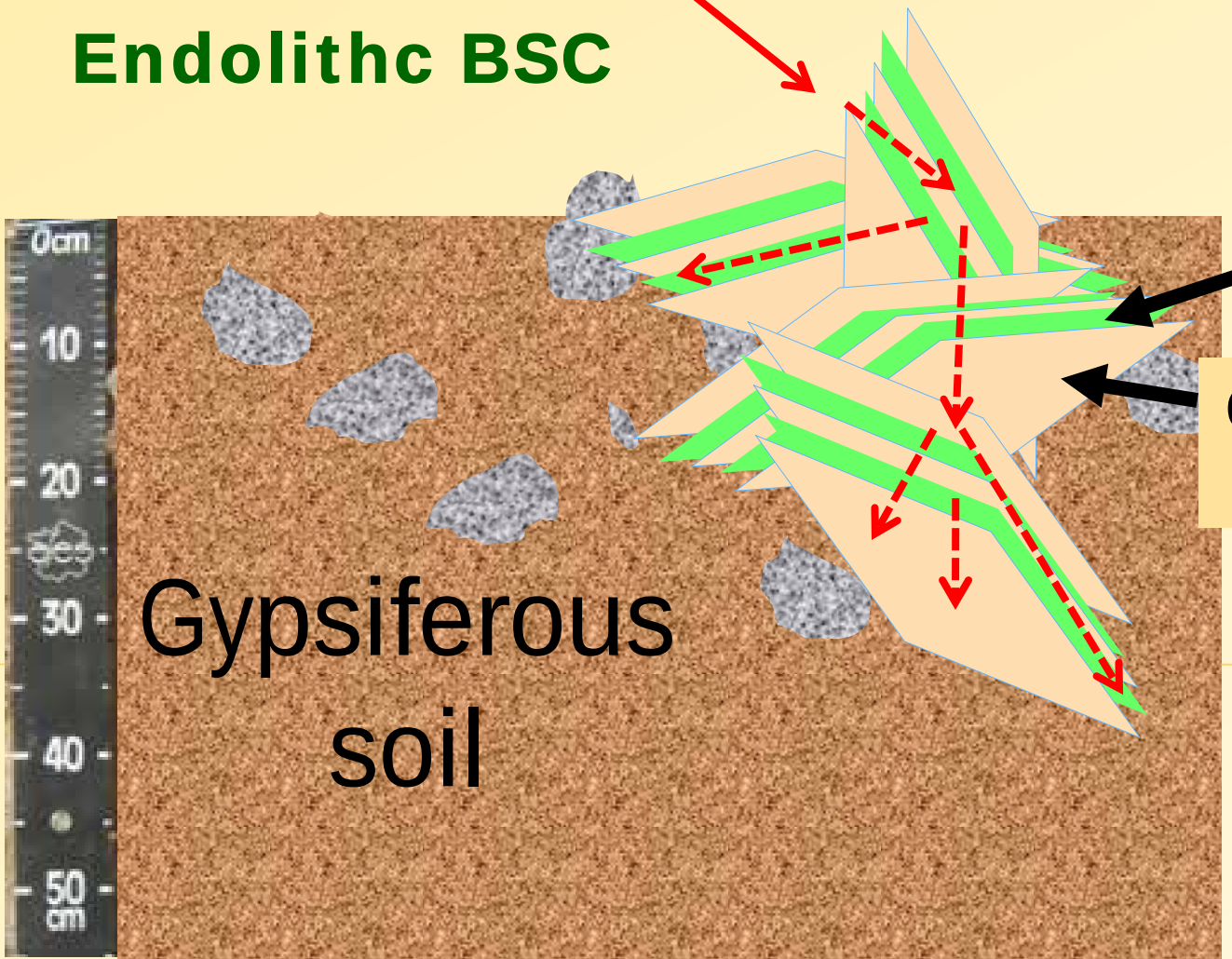
Fossil Valley

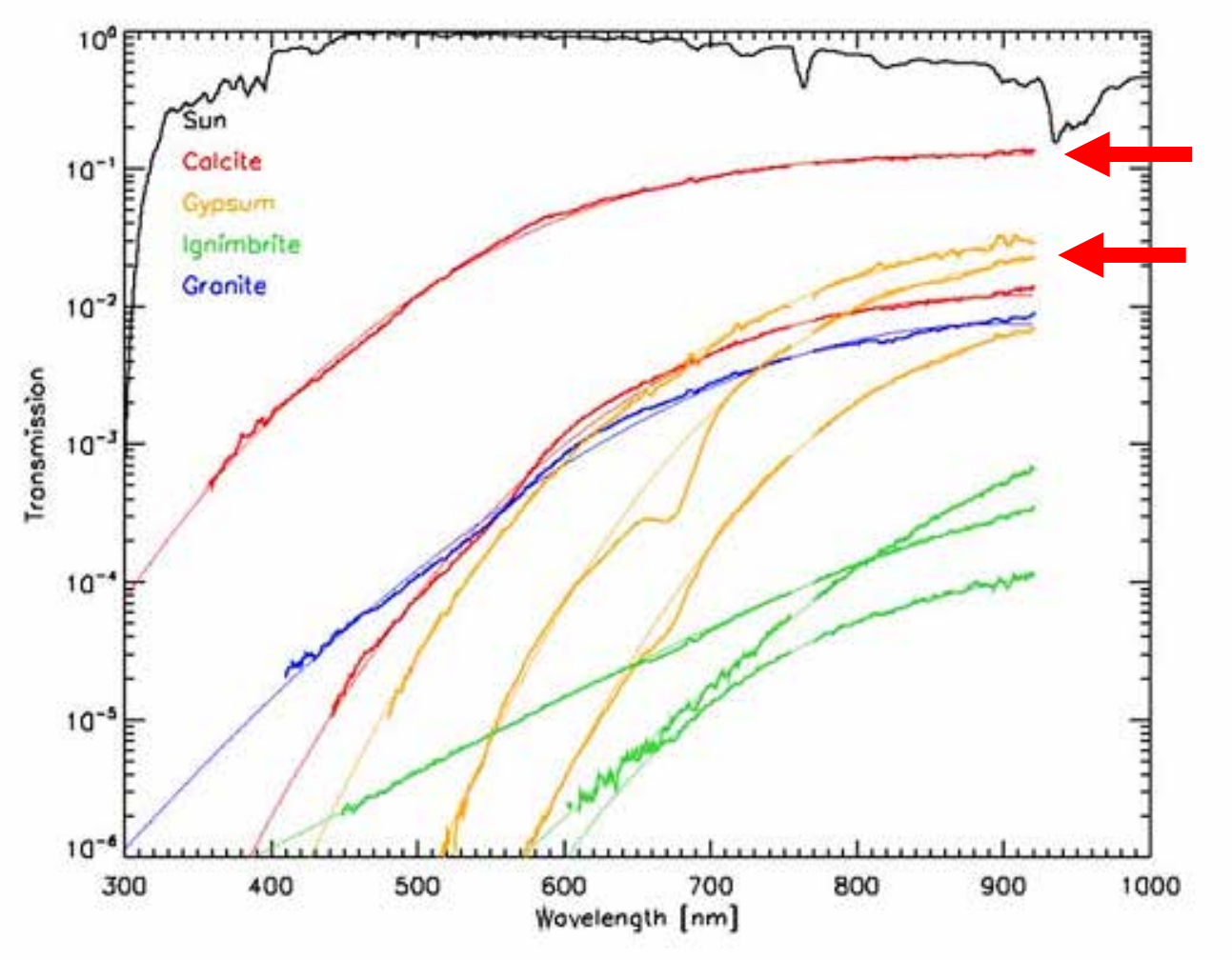
Chott/Sabkha

hyper-arid Sahara (Holt Desert)

Photoautotroph layers wihin translicid lenticular Gypsum crystals

Endolithc BSC





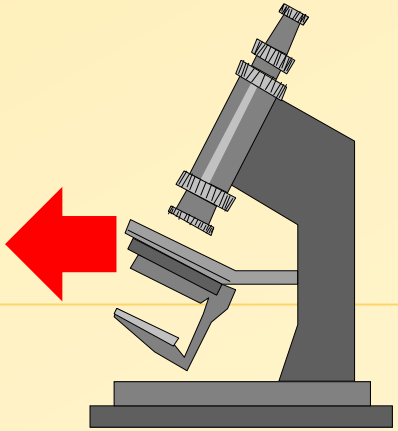
Light transmission spectra at the nominal depth of 2 mm from the surface of the rocks for calcite, granite, gypsum and ignimbrite (Meslier *et al.*, 2018)

Field sampling of non disturbed soil material (including BSCs)

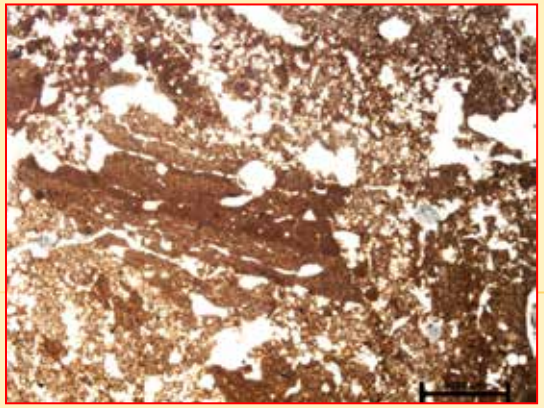
Impregnated simple

Thin section

Impregnation and manu-facturing soil thin section



Polarized microscope



Micrograph

Micromorpholgy description

Results and discussions

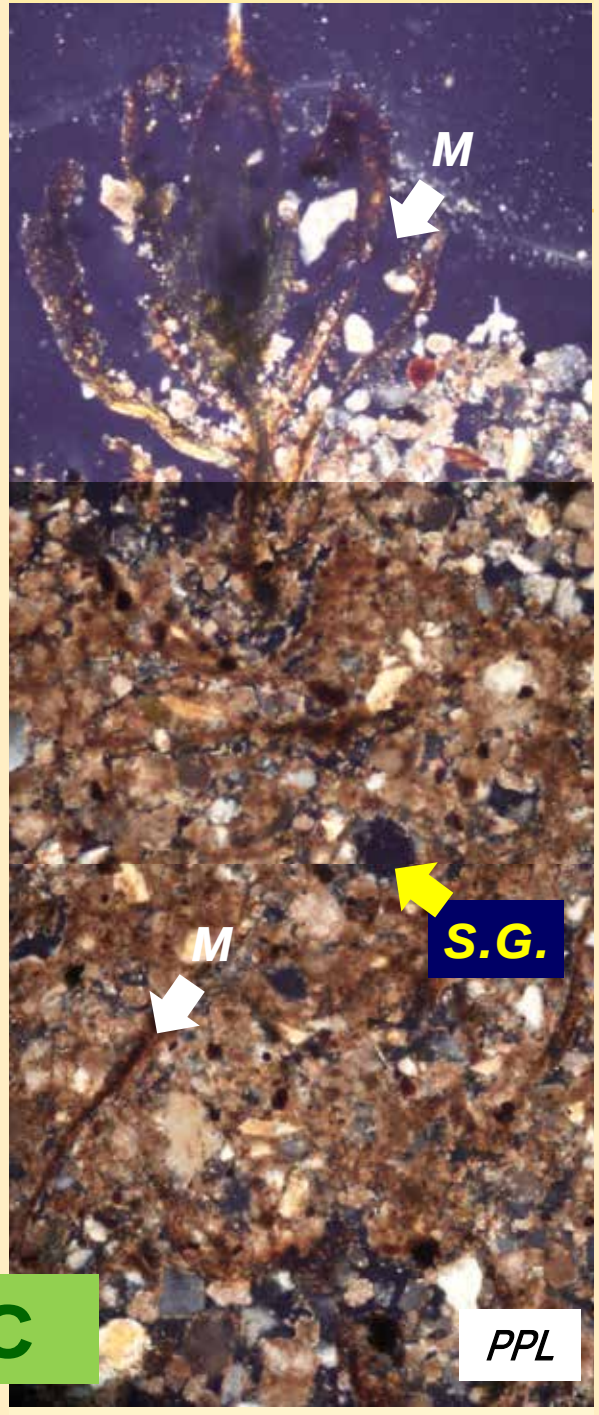
Soil thin section sample

Epilithic BSC

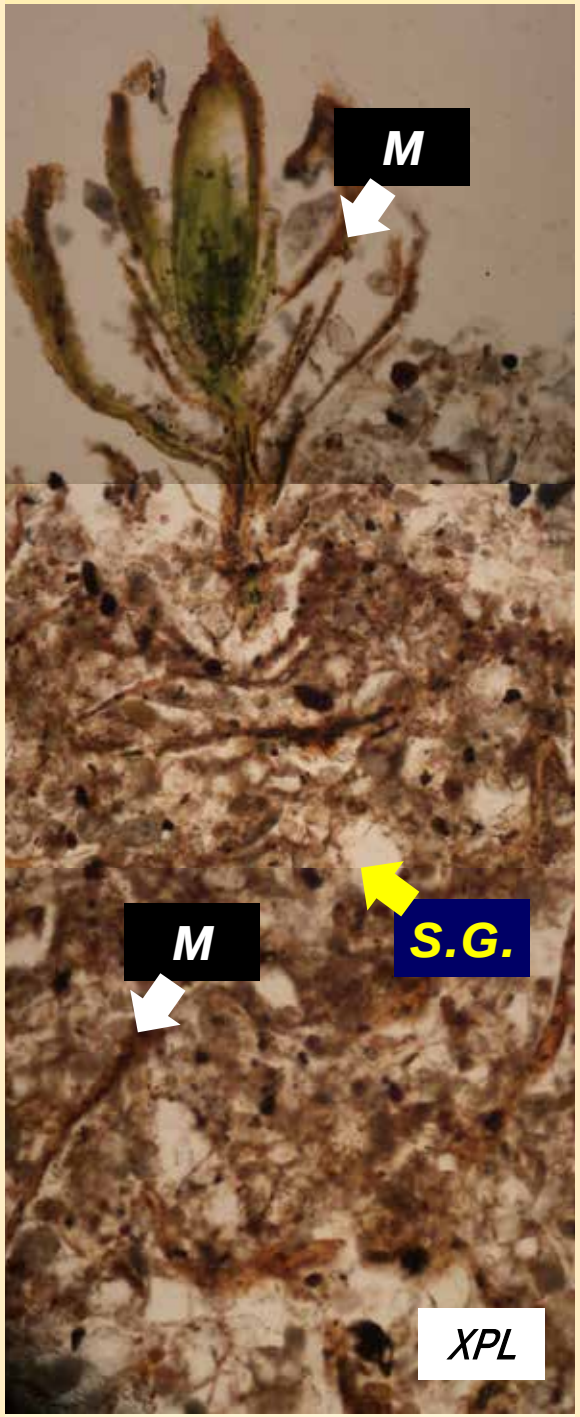
Vertical thin section of BSC on a sandy soil (Djelfa steppe-land), mainly composed of mosses (M), which trap sand grains

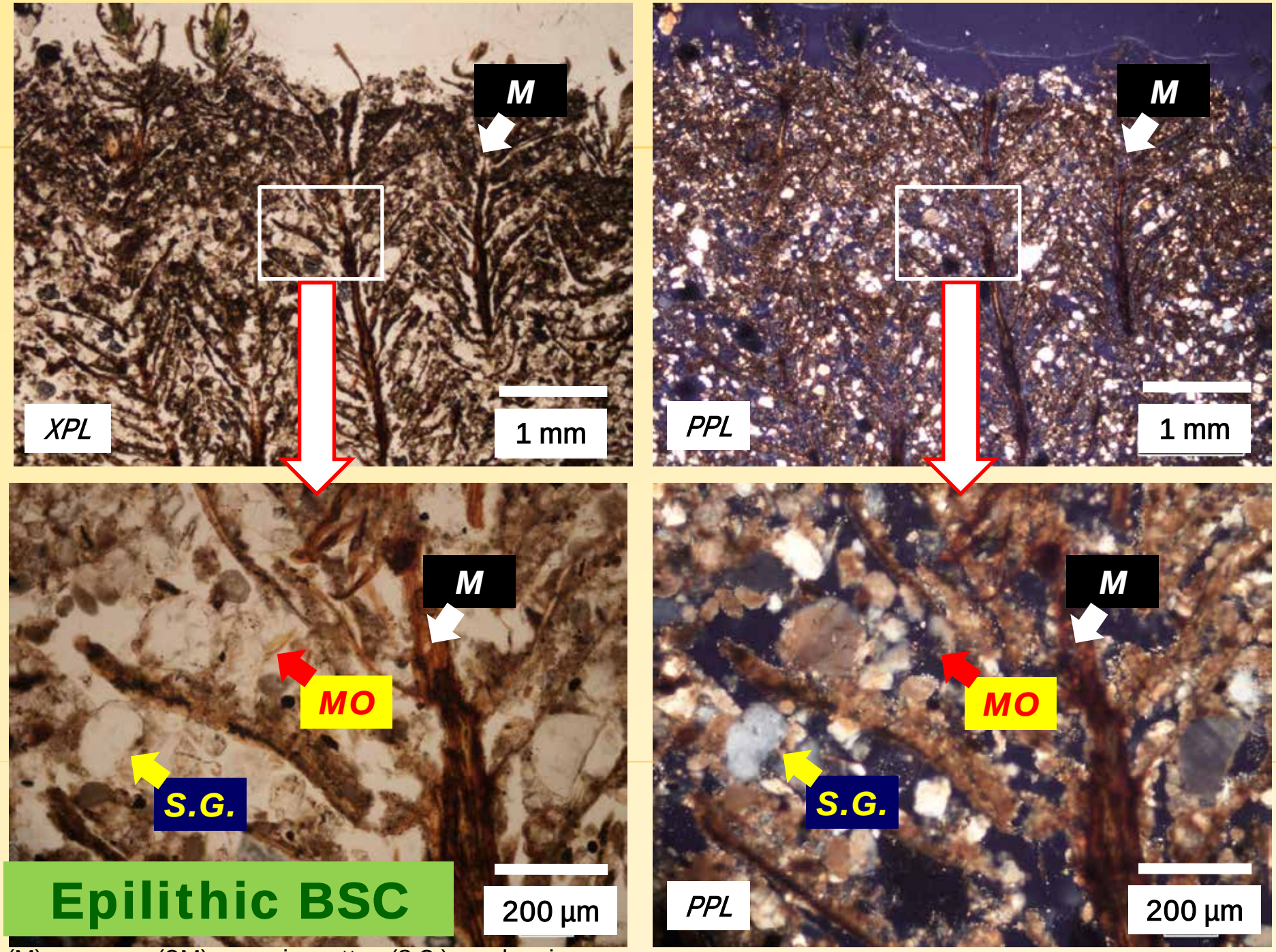
Top soil

Epilithic BSC

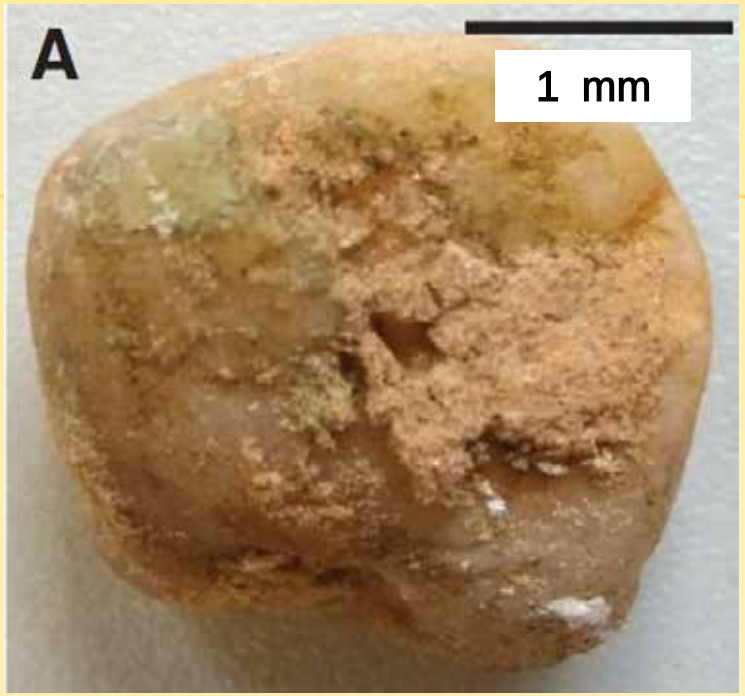


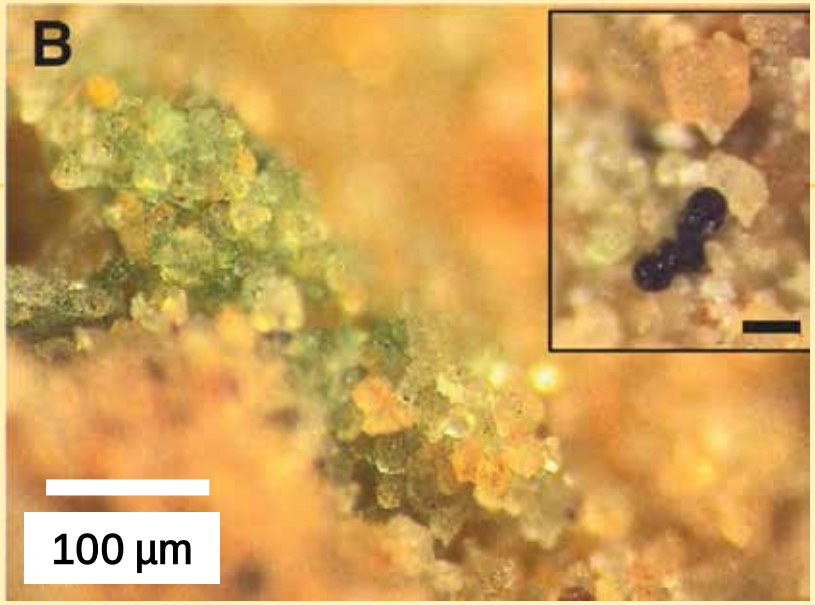
1 mm



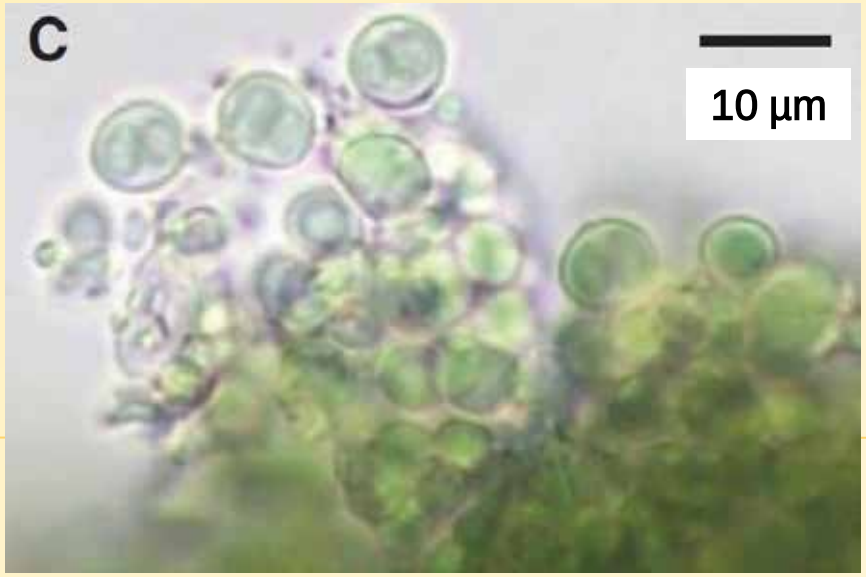


(M): mosses ; (OM): organic matter; (S.G.) sand grains



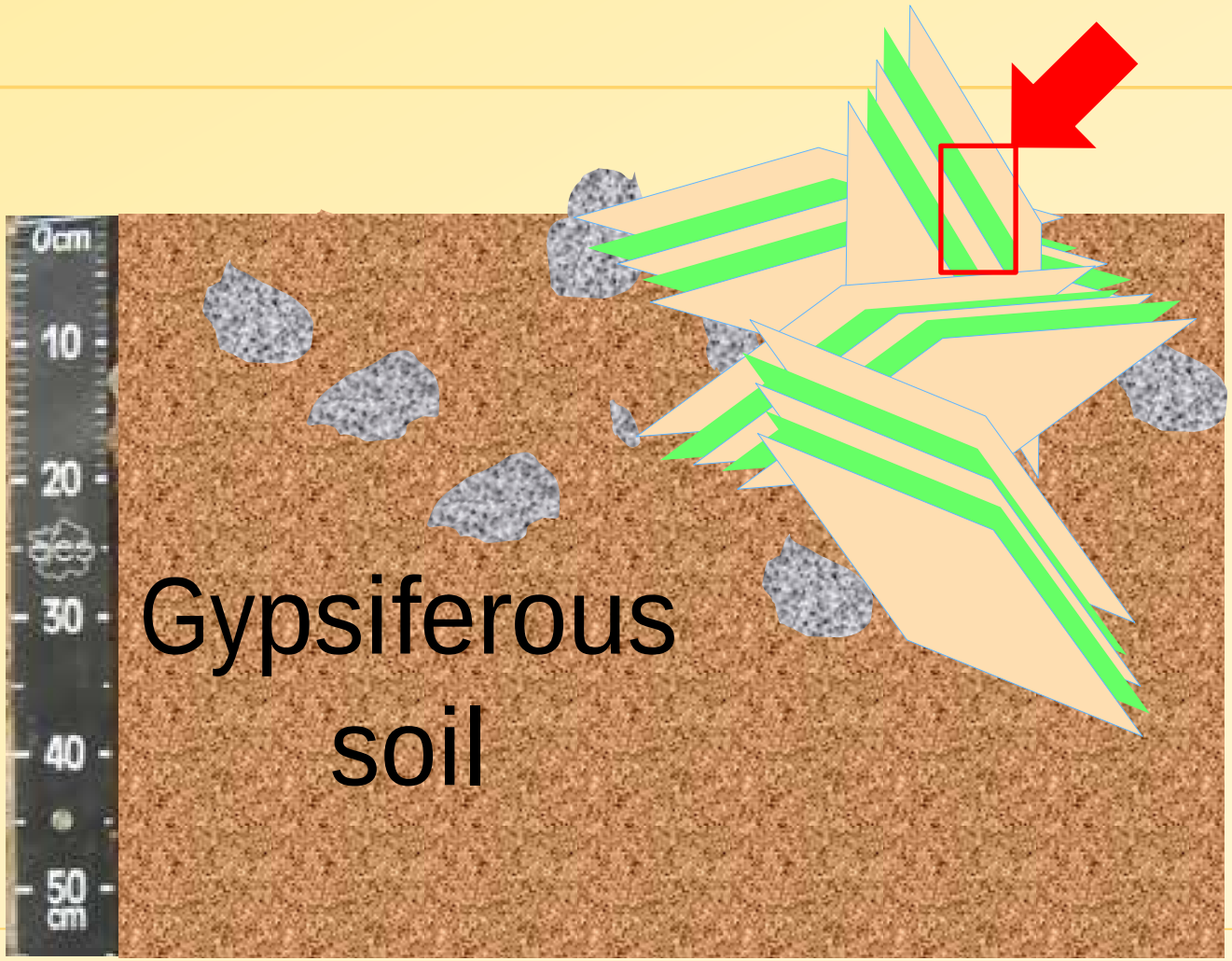


Hypolithic community obtained from the sandy soil underside of a quartz stone



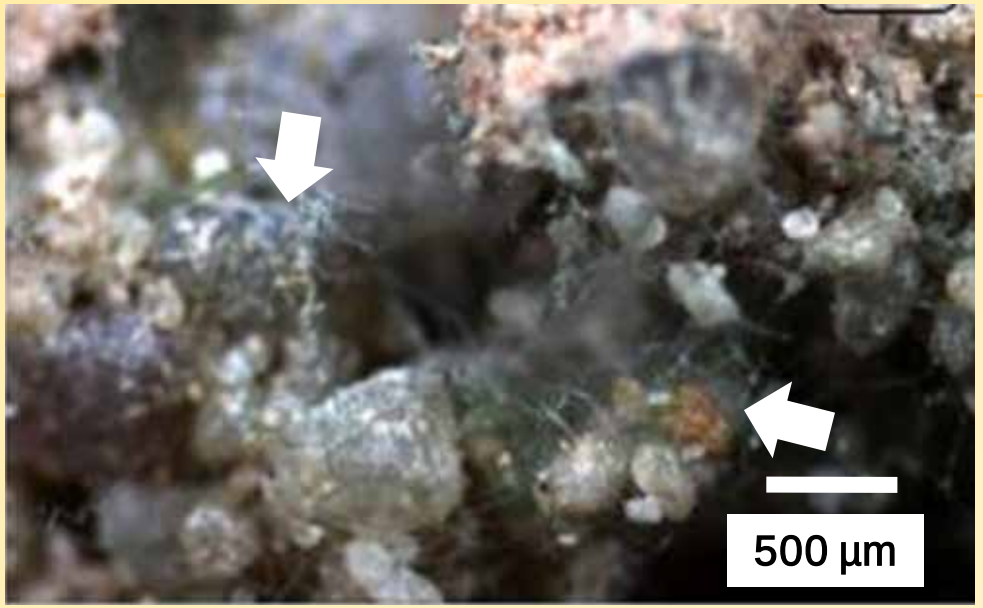
Microphotographs of coccoid (*Chrooccoccidiopsis spp.)*

Hypolithic BSC



Soil thin section sample

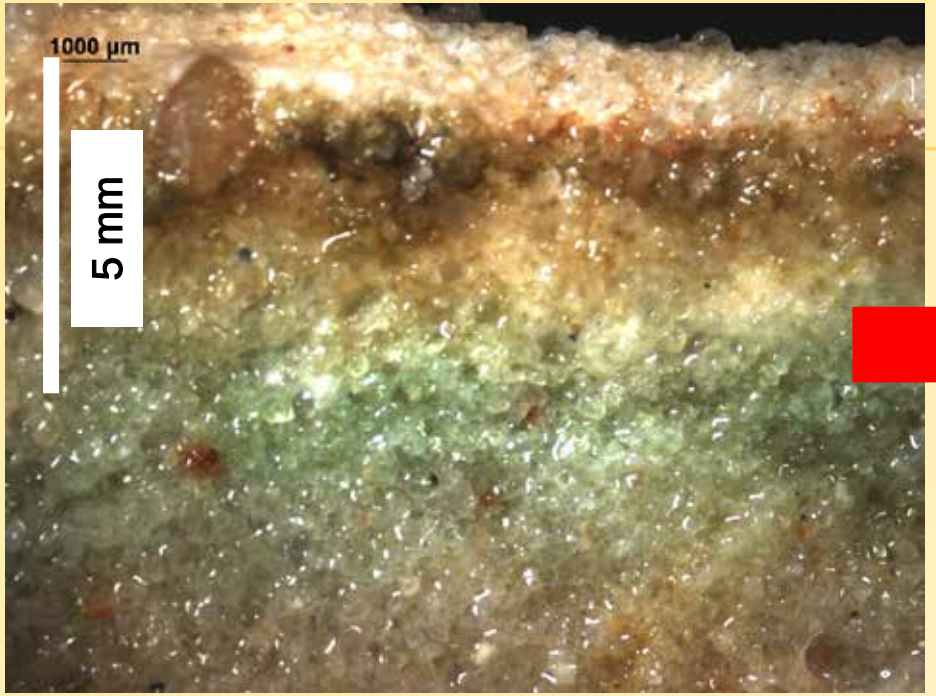
Endolithic BSC

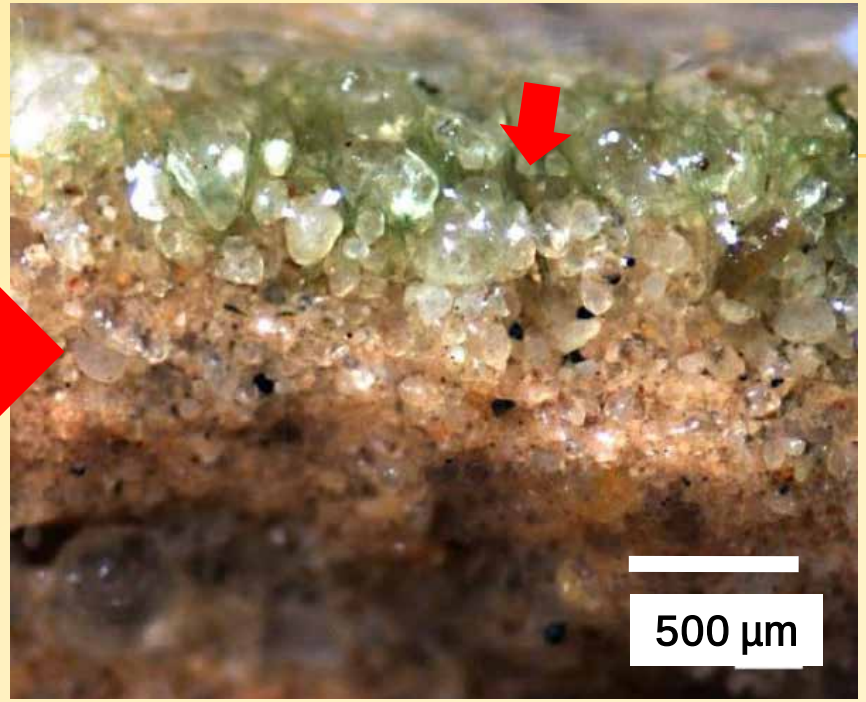


Sand grains sutured by bio-material
(cyanobacteria , fungi and/or polysaccharides)

Promote soil structuration
(micro-structure)

Endolithic BSC

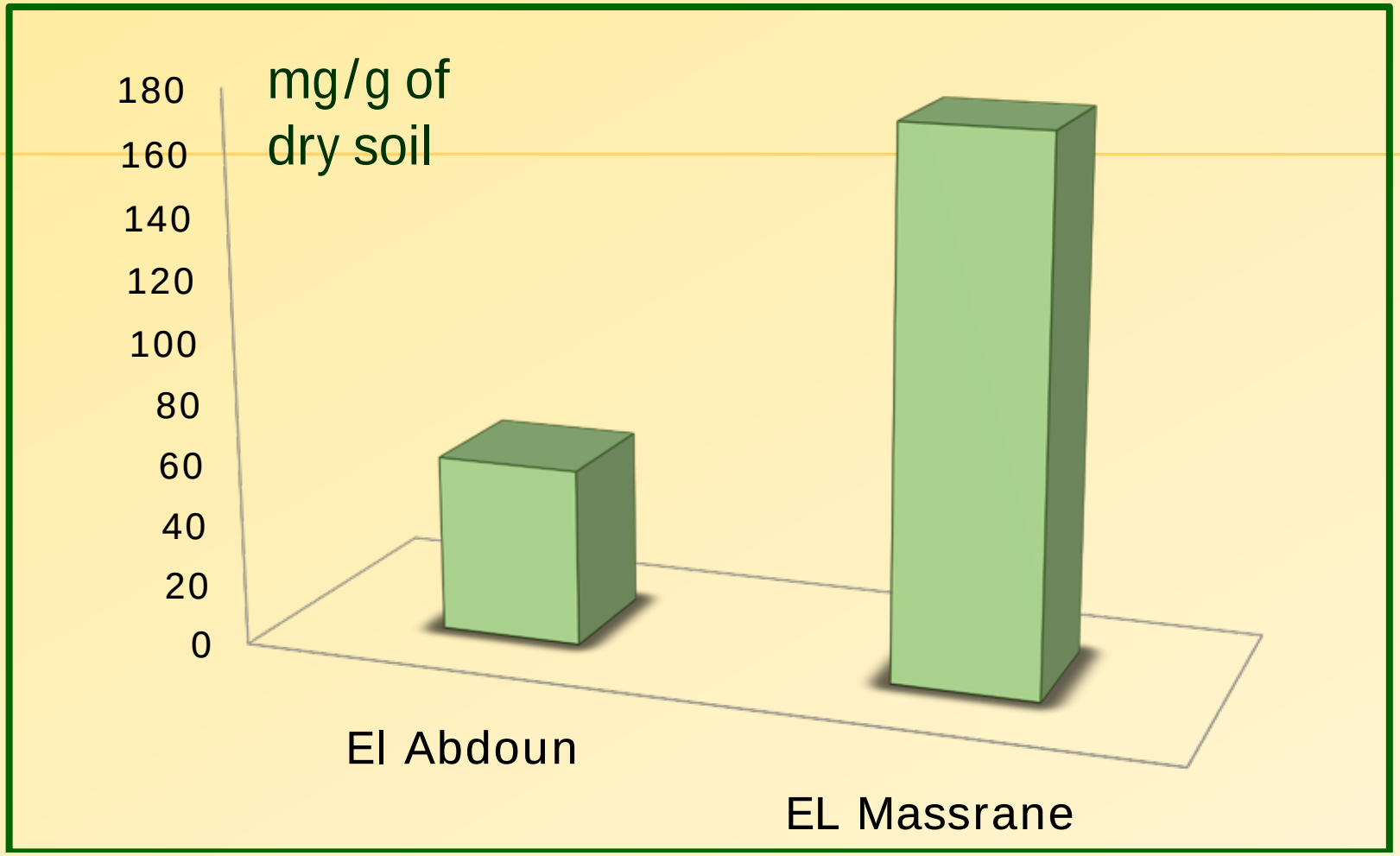




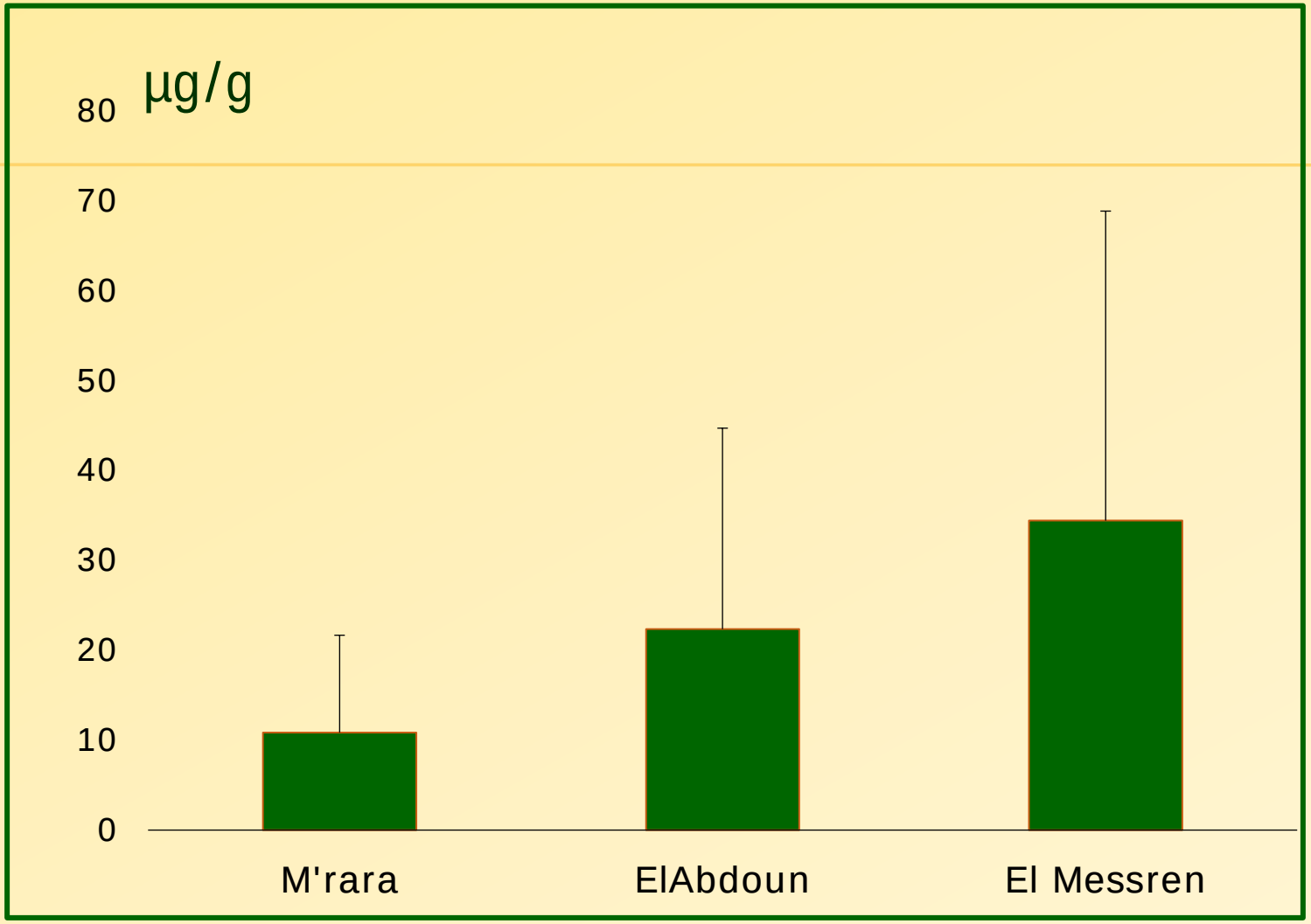
Sand grains coated by thin layer of cyanobacteria

Promote soil structuration (micro-structure)

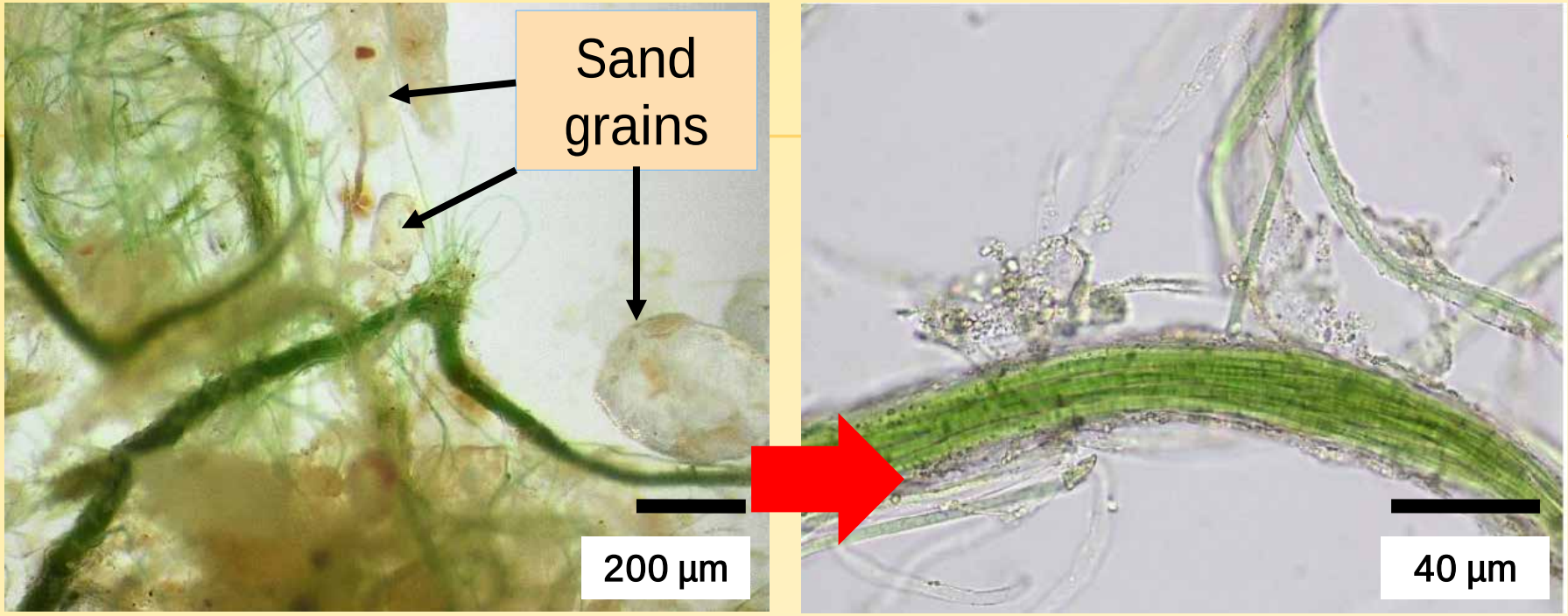
Endolithic BSC



Exopolysachride extracts from cyanobacteria isolates from epilithic Biocrust the Sahara desert (El Abdoun) and Steppe-land (El Mesran) soils (Benzaid and Souigat, 2025)



Chlorophyll extract from Biocrust in two Sahara desert (M’Rara and El Abdoun) and Steppe-land (El Mesran) soils (Benzaid and Souigat, 2025)

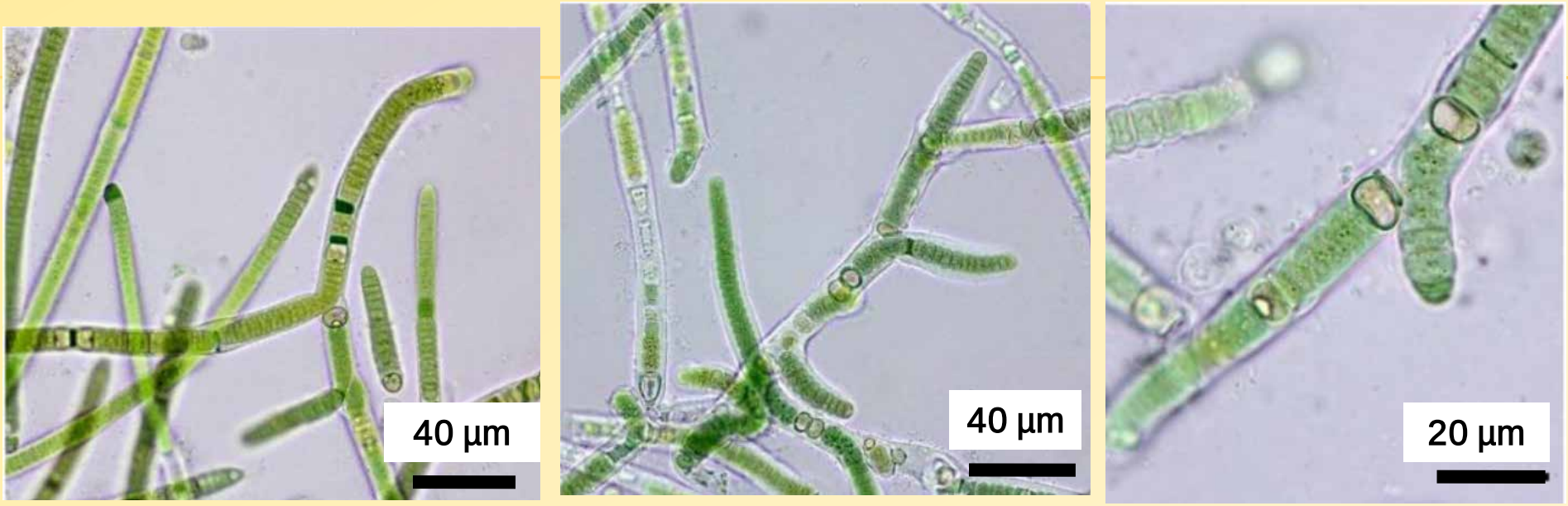


Microcoleus spp., together with motile filaments migrating from the bundles

Endolithic BSC

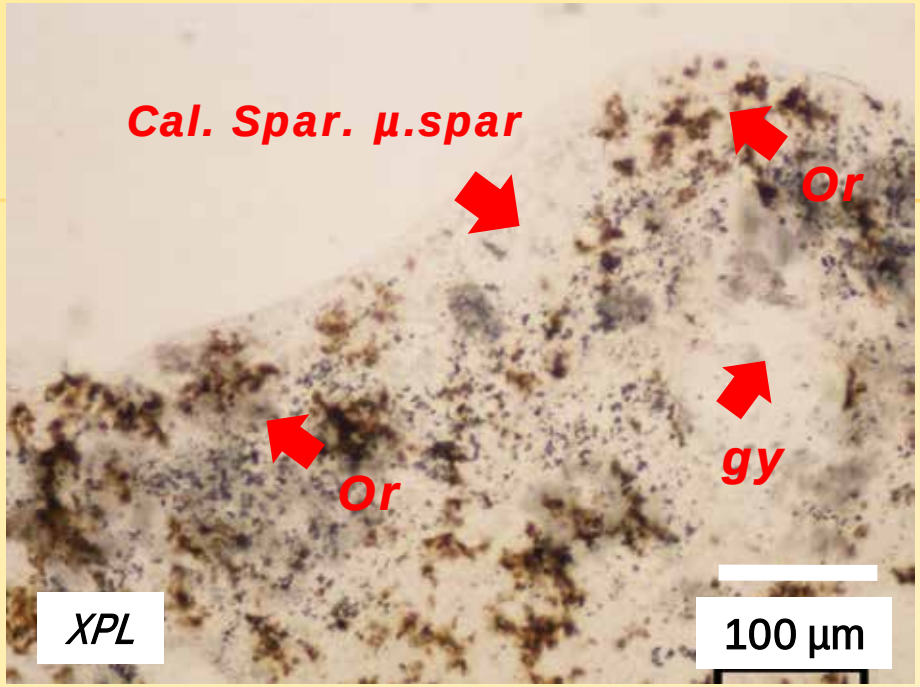
Microphotographs of non-heterocystous cyanobacterial strains (*Microcoleus vaginatus* LSB45)

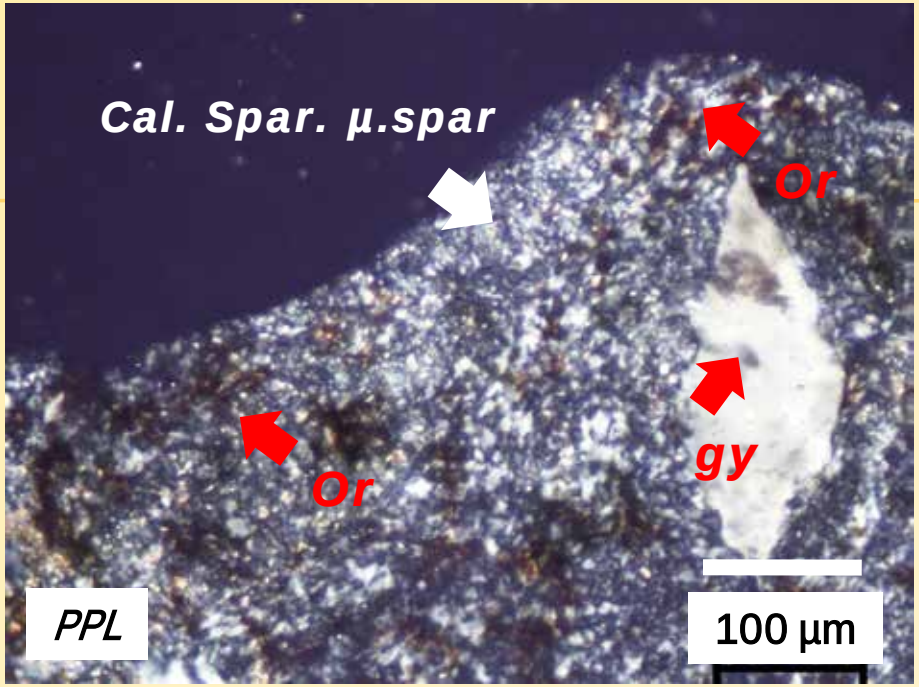
Endolithic BSC



Microphotographs of heterocystous cyanobacterial strains (*Tolypothrix distorta* LSB87)

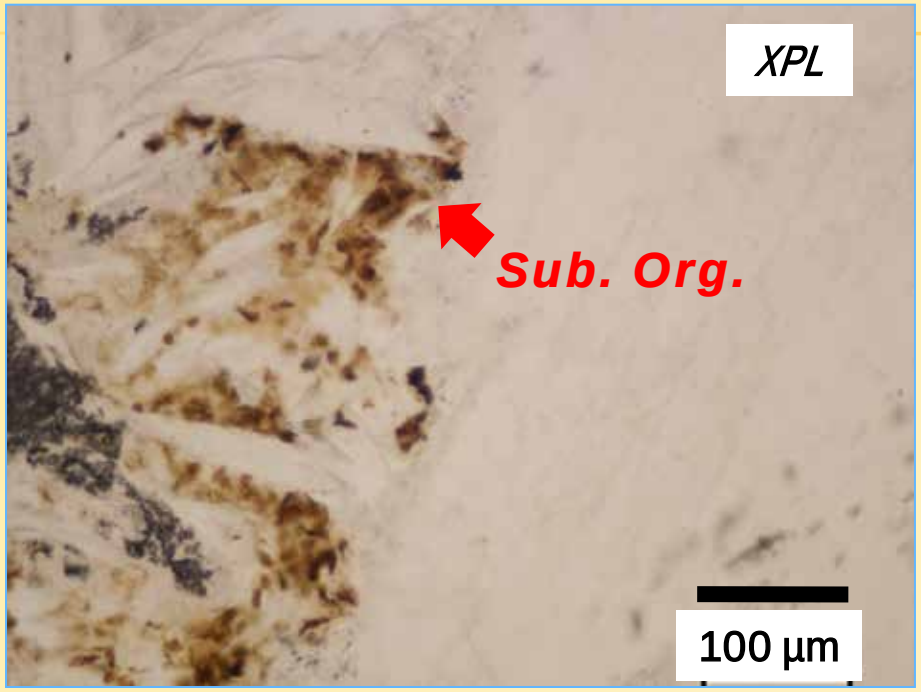
Endolithic BSC

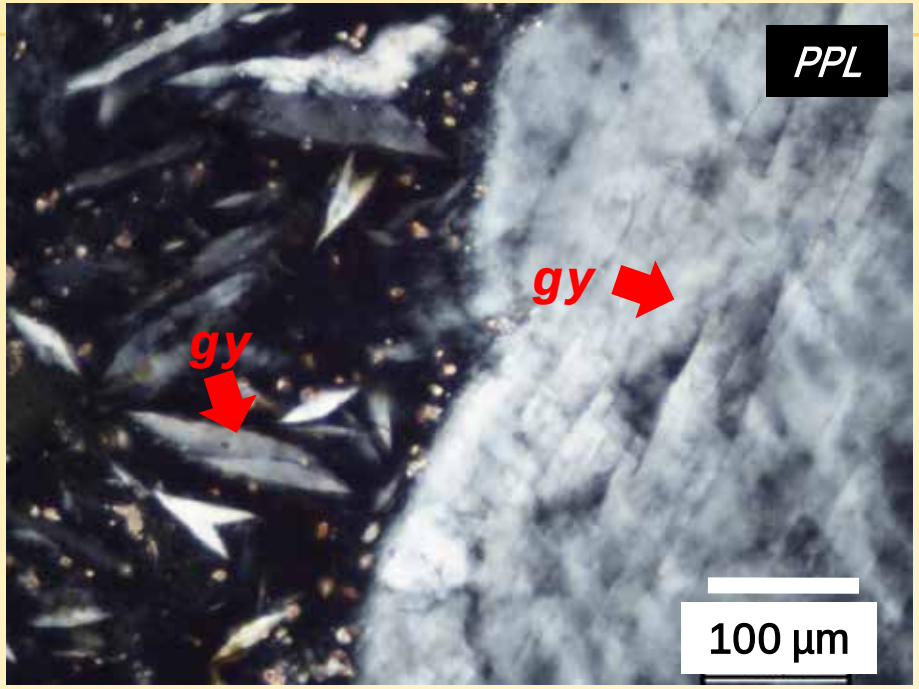




Organic pedofeatures include organic residues (Or) and, sparite and/or micro-sparite calcite (smc) and gypsum crtytals (gy), in endolithic BSC of gypsic-calcic horizon

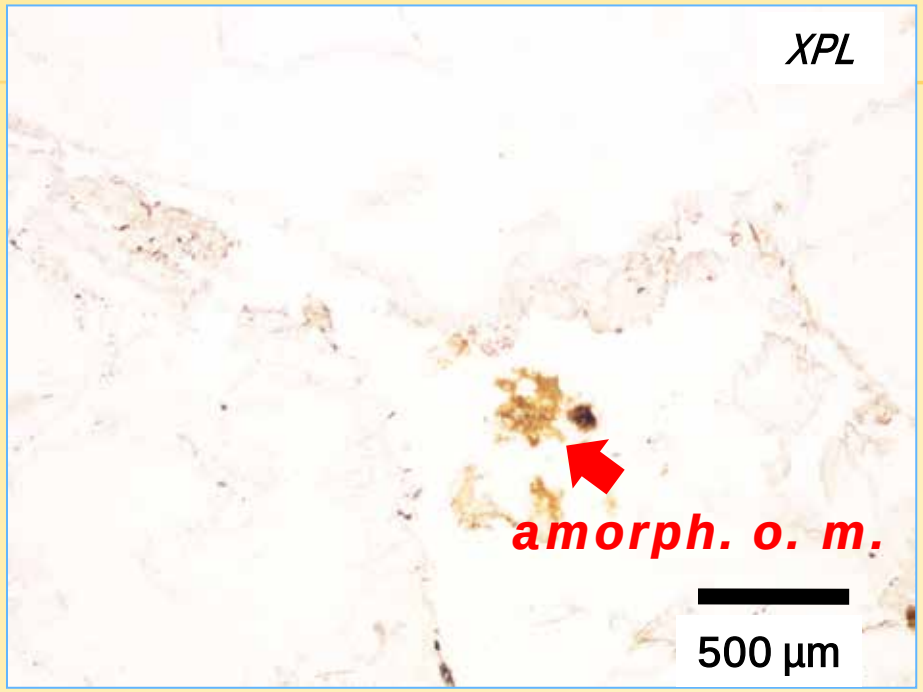
Endolithic BSC

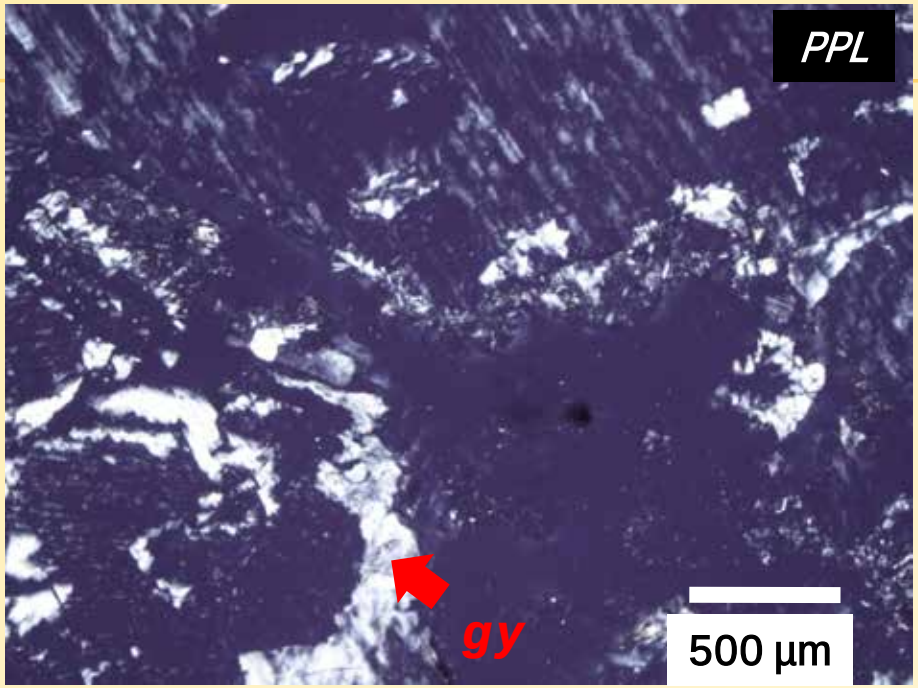




Interaction organic pedofeature (sub. Org) / gypsic cristalline pedofeatures (gy) (lenticular gypsum) wihine a sandy petrogypsic horizon.

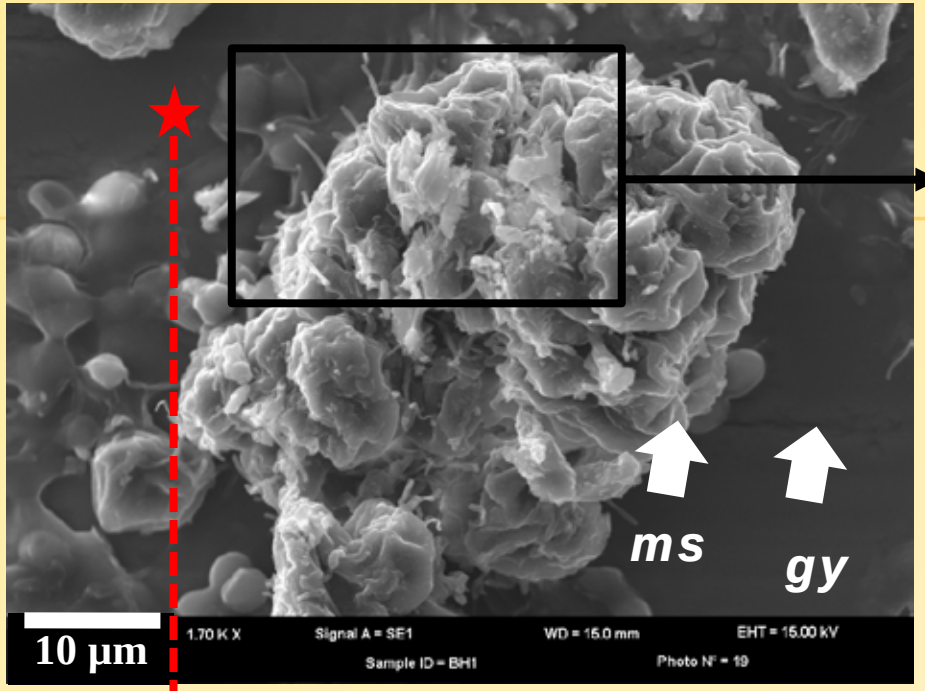
Endolithic BSC

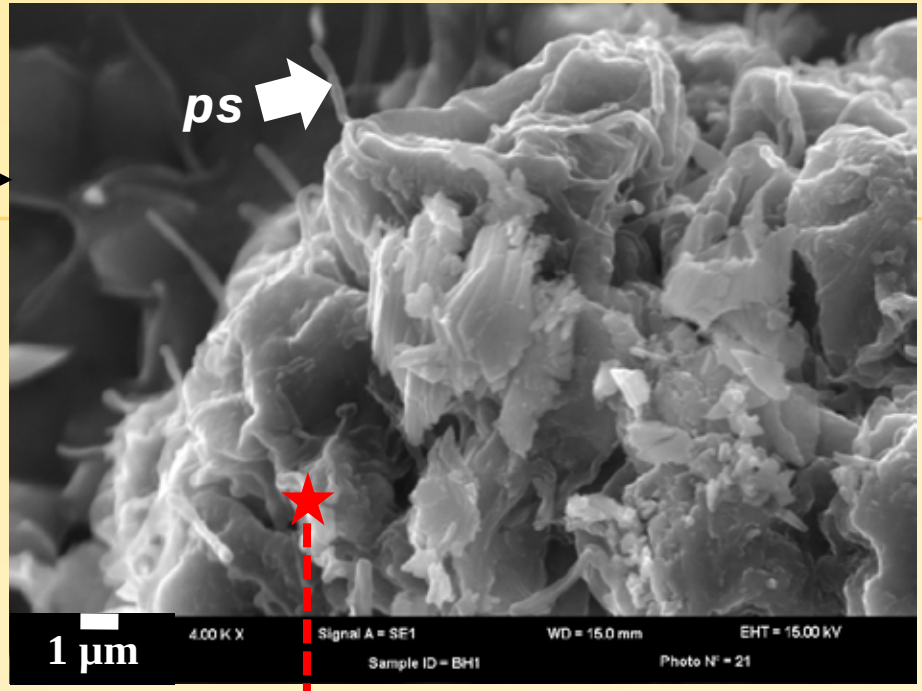


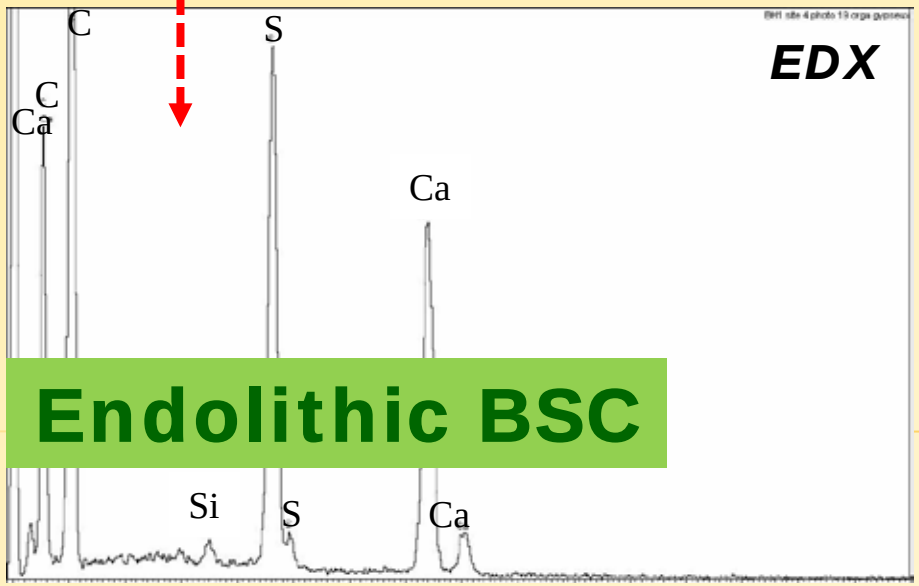


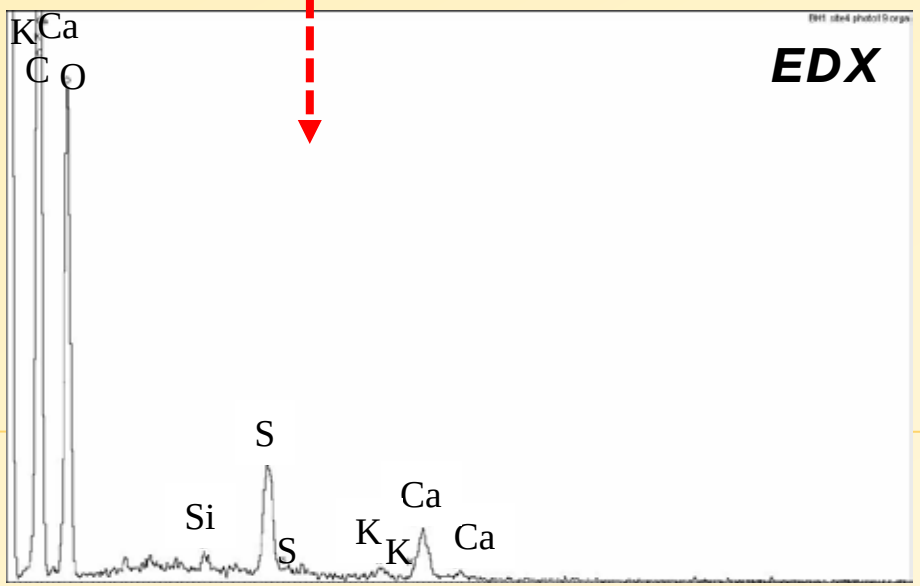
Amorphous organic matter (pigments) infilling soil porosity (endolithic BSC within gypsic horizon)

Endolithic BSC



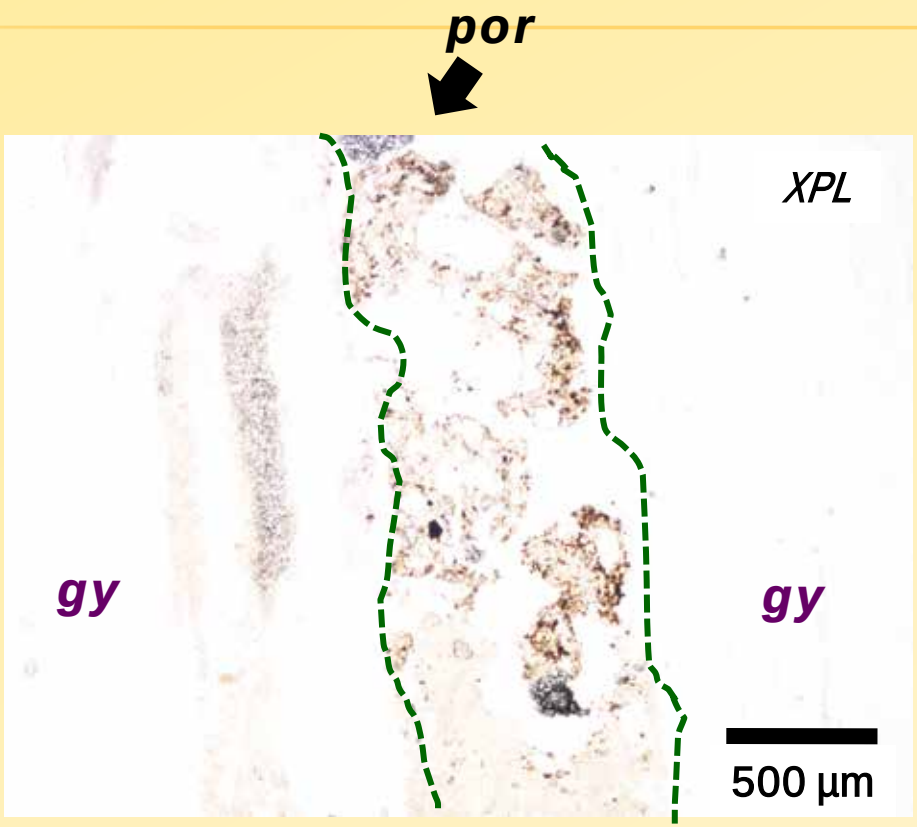


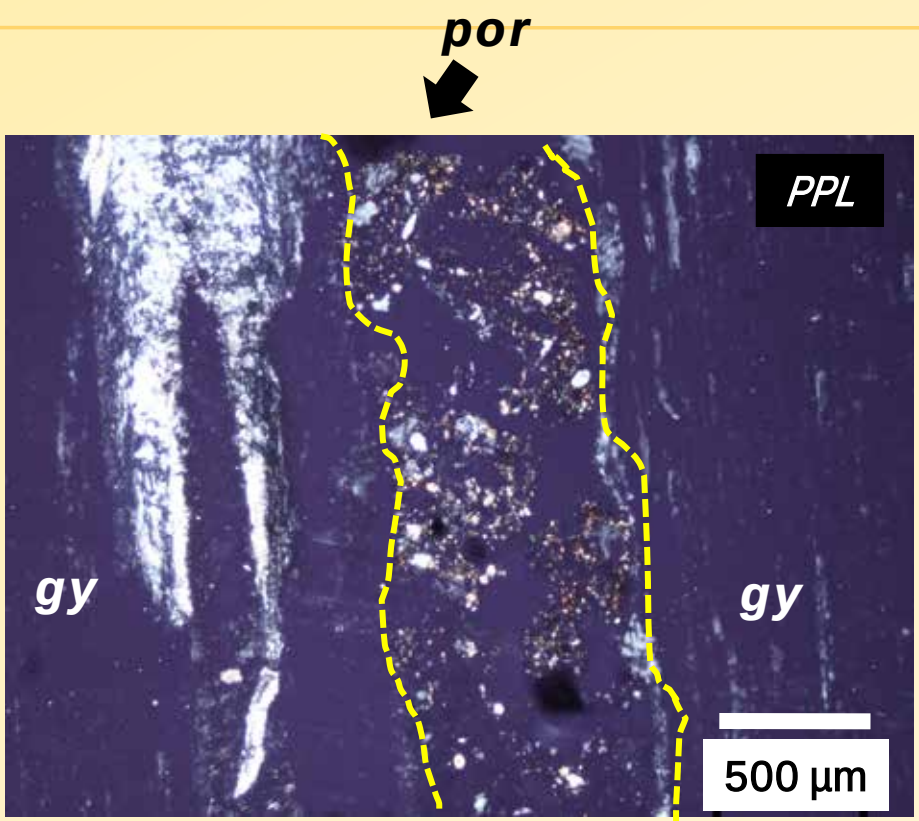




Endolithic BSC

SEM micrograraph: micro-structure (ms) of organo-miniral complex showing polymeric substances (ps)

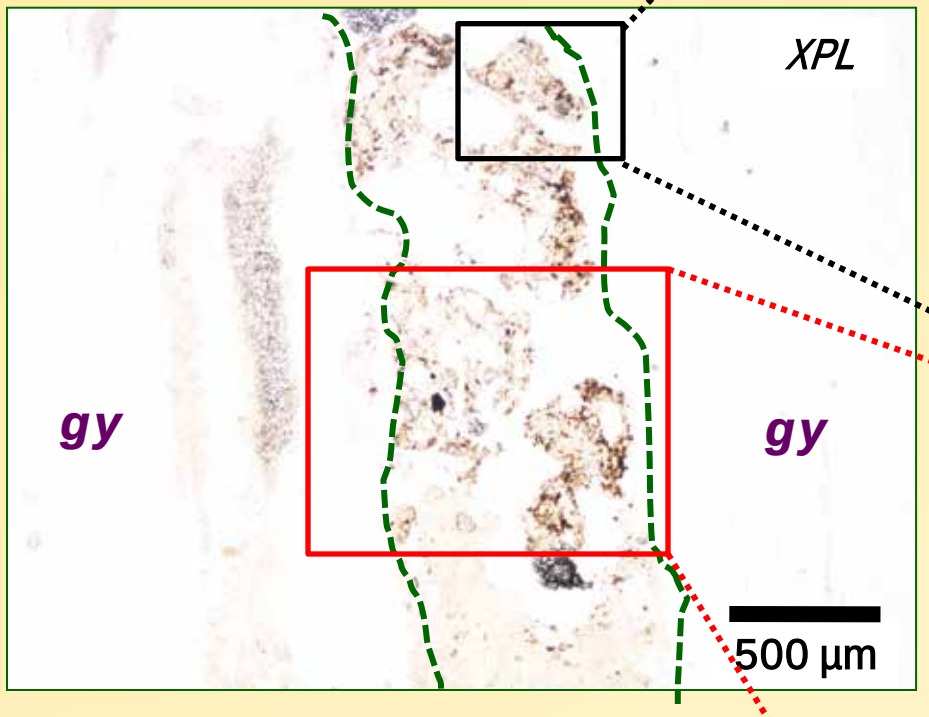


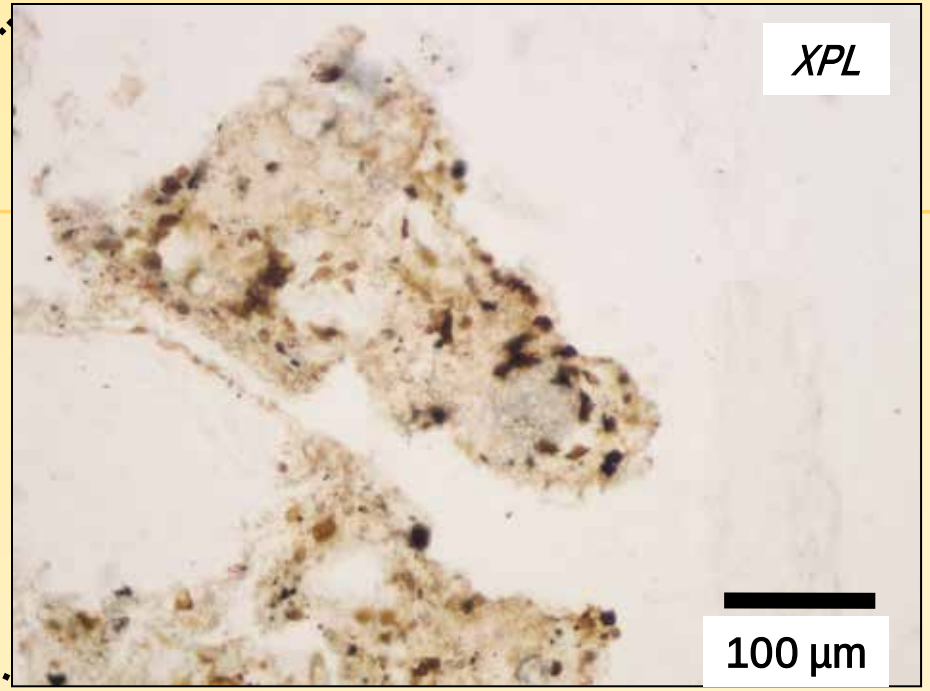


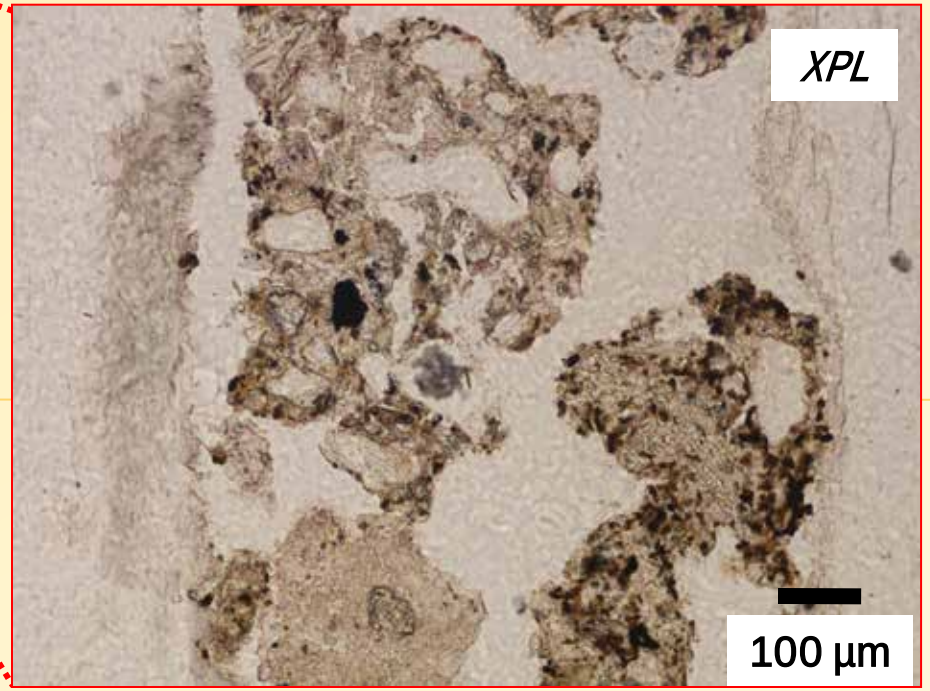
Soil structure genesis whine gypsum crystal macro-porosity

Endolithic BSC

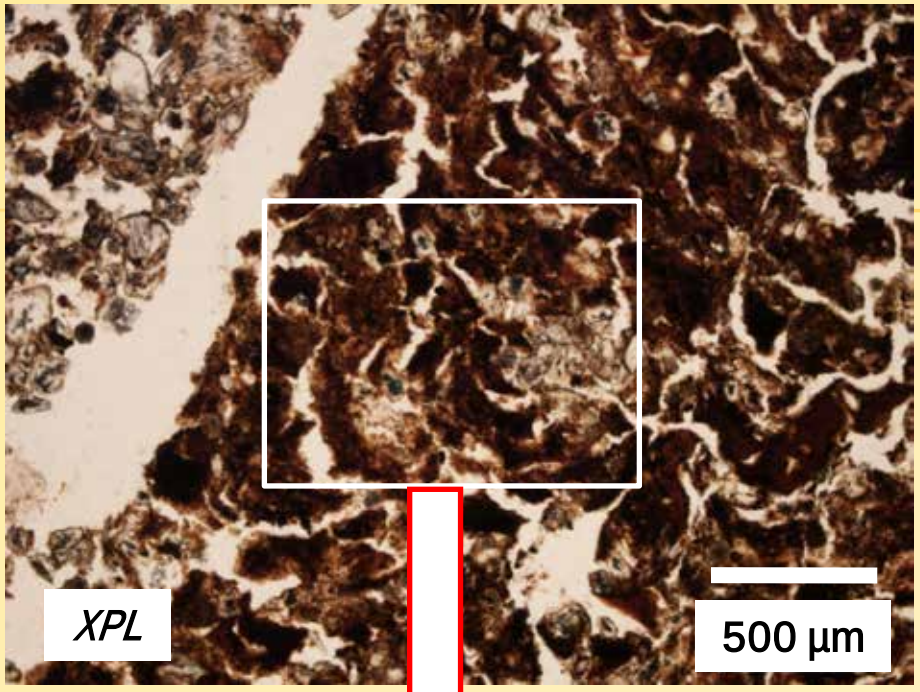
Endolithic BSC

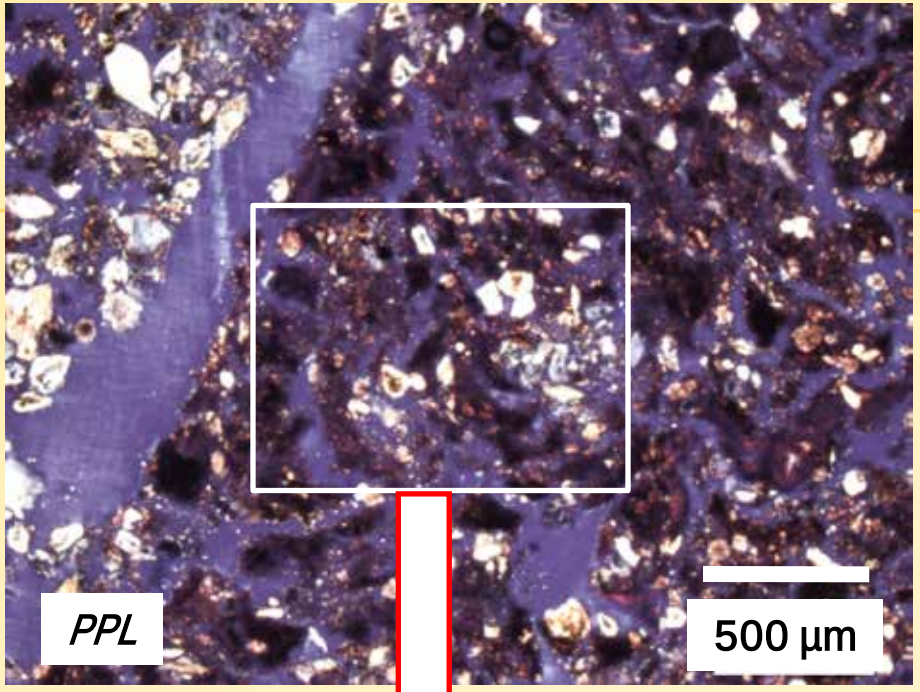


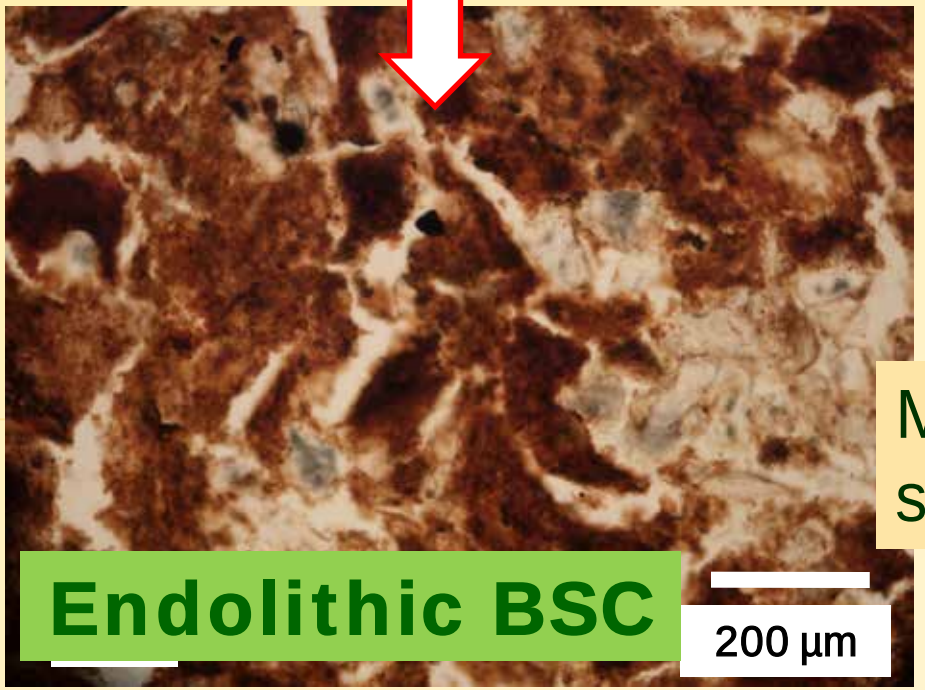


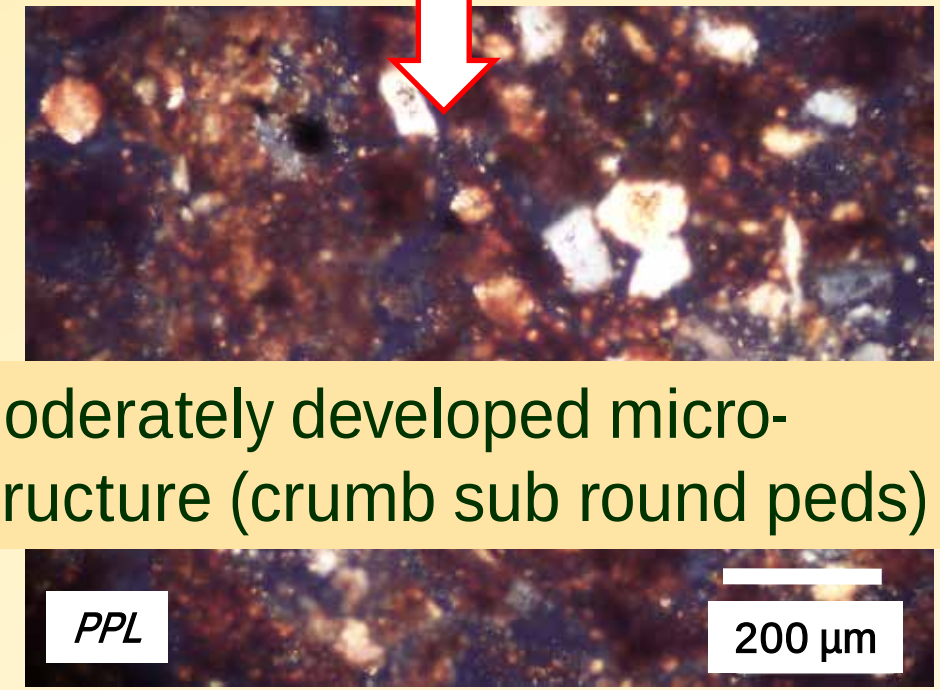


Well developed micro-structure (sub angular blocky peds).
Component: OM, bio-material, gypsum and calcite









Moderately developed micro-structure (crumb sub round peds)

Conclusion

- Saharan BSCs promote soil structure and porosity
- In Steppe lands Epilithic BSC traps sand grains and stabilize gypsic sandy soils
- BSCs enhance soil organic matter (i.e. nutrient and C sequestration)
- Gypsum crystals constitute an important micro-habitat for photoautotrophs in the Sahara desert ecosystem

What’s the next step?

What's the next step?

What's the next step?

Semi-arid Atlas Montaigne

Semi-arid Atlas Montaigne

Semi-arid Atlas Montaigne


Semi-arid Atlas Montaigne


Sahara Desert Montaigne (Tassili)

Sahara Desert Montaigne (Hoggar)

Sahara Desert Montaigne (Hoggar and Tassili)

Sahara Desert Montaigne (Hoggar and Tassili)

environmental microbiology

Environmental Microbiology (2021) **00**(00), 00–00 doi:10.1111/1462-2920.15850

Lithic cyanobacterial communities in the polyextreme Sahara Desert: implications for the search for the limits of life

Smail Mehda,[1,2,3] M. Ángeles Muñoz-Martín,[1] Mabrouka Oustani,[4] Baelhadj Hamdi-Aïssa,[2] Elvira Perona[1] and Pilar Mateo[1*]

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Summary

The hyperarid Sahara Desert presents extreme and persistent dry conditions with a limited number of hours during which the moisture availability, temperature and light allow phototrophic growth. Some cyanonon-heterocystous cyanobacteria. Thermophysiological bioassays confirmed desiccation and extreme temperature tolerance as drivers in the cyanobacterial community composition of these lithic niches. The results of the present study provide key factors for understanding life strategies under polyextreme environmental conditions. The isolated strains, especially the newly described cyanobacterium *P. sahariense*, might represent suitable microorganisms in astrobiology studies aimed at investigating the limits of life.

Introduction

Drylands that experience large shifts in temperature, low moisture availability and high exposure to UV radiation, such as deserts, characterize a vast extension of the terrestrial biome that comprises approximately one-third of the Earth's land surface. In addition, some deserts are subjected to more extreme environmental conditions, presenting aridity index values lower than 0.05, and are considered hyperarid deserts (Pointing and Belnap, 2012).

microorganisms

MDPI

Article

Microenvironmental Conditions Drive the Differential Cyanobacterial Community Composition of Biocrusts from the Sahara Desert

Smail Mehda [1,2,3], M. Ángeles Muñoz-Martín [1], Mabrouka Oustani [4], Baelhadj Hamdi-Aïssa [2], Elvira Perona [1] and Pilar Mateo [1,*]

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Abstract: The Sahara Desert is characterized by extreme environmental conditions, which are a unique challenge for life. Cyanobacteria are key players in the colonization of bare soils and form assemblages with other microorganisms in the top millimetres, establishing biological soil crusts (biocrusts) that cover most soil surfaces in deserts, which have important roles in the functioning of drylands. However, knowledge of biocrusts from these extreme environments is limited. Therefore, to study cyanobacterial community composition in biocrusts from the Sahara Desert, we utilized a combination of methodologies in which taxonomic assignation, for next-generation sequencing of

Citation: Mehda, S.; Muñoz-Martín, M.Á.; Oustani, M.; Hamdi-Aïssa, B.; Perona, E.; Mateo, P. Microenvironmental Conditions Drive the Differential Cyanobacterial

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Laboratoire de Biogéochimie des Milieux Désertiques
Université Kasdi Merbah Ouargla

INRA EcoSys
Science & Impact

DGRSDT
من أجل بحث علمي مفيد ...

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Plant Ecology & Systematics

INRF


Call for collaboration !!
for
Sahara Biocrust Safari


Welcome


Thanks
“MariPar”