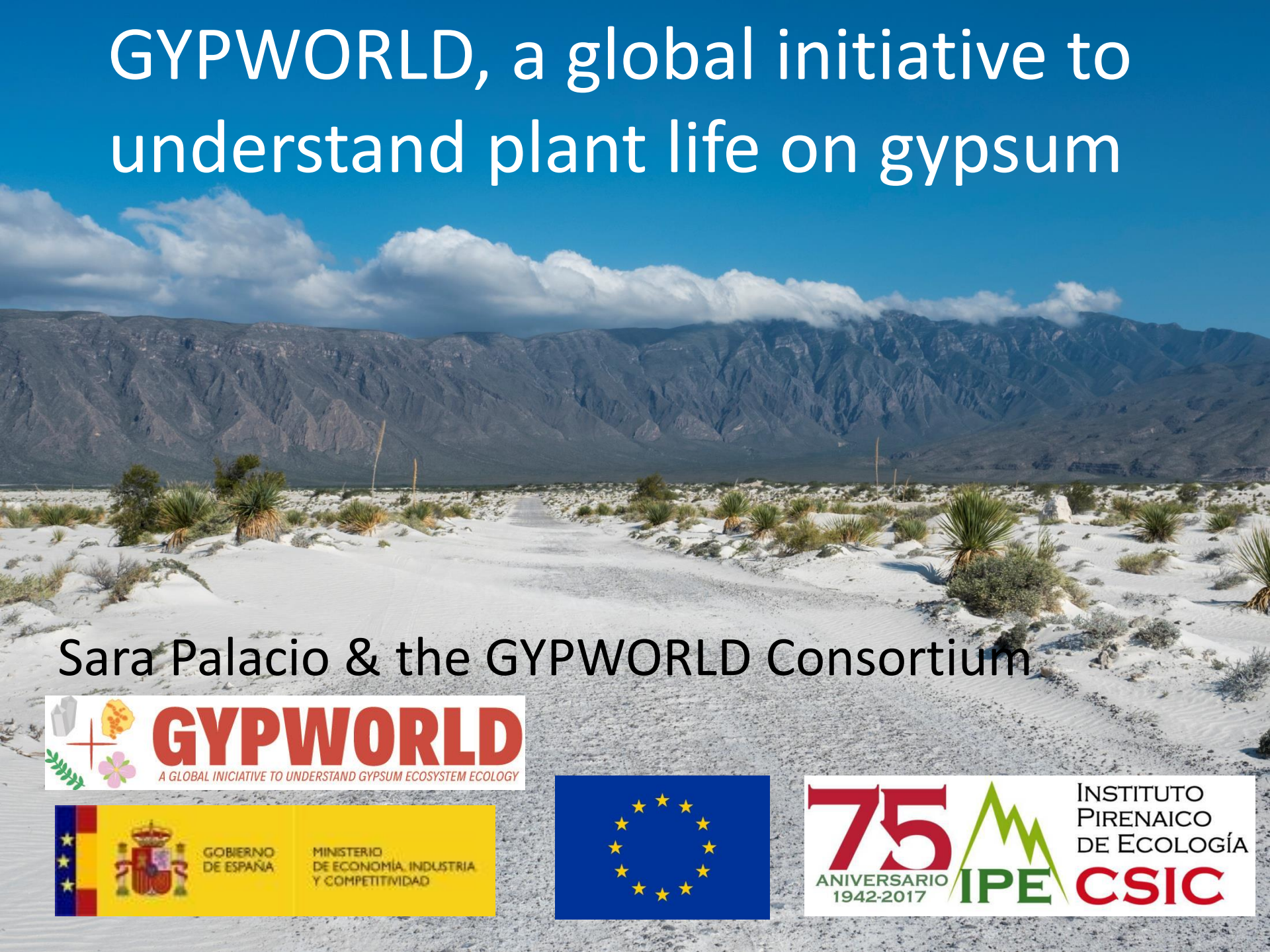
GYPWORLD, a global initiative to understand plant life on gypsum



Sara Palacio & the GYPWORLD Consortium

GYPWORLD
A GLOBAL INICIATIVE TO UNDERSTAND GYPSUM ECOSYSTEM ECOLOGY

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

75 ANIVERSARIO 1942-2017
IPE
INSTITUTO PIRENAICO DE ECOLOGÍA
CSIC

Special substrates and plant life

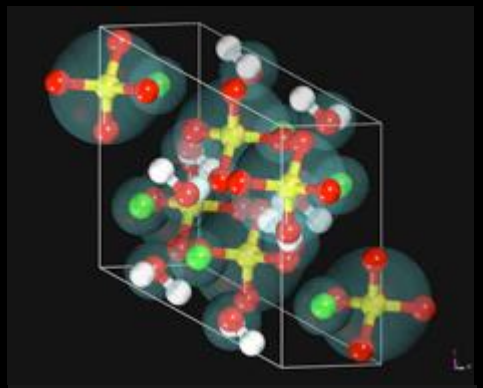
Serpentine soils in Sierra Bermeja, Málaga

Gypsum outcrops in Zaragoza, SLP, México

Edaphic islands that represent natural laboratories of evolution and ecology

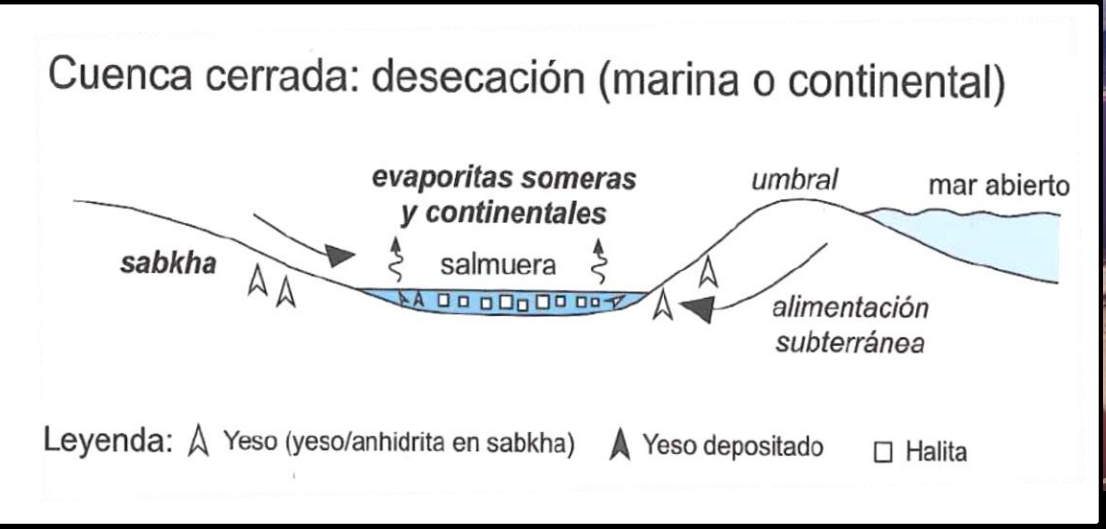
Gypsum outcrops in Mexico, between la Laguna, Cuatrociénegas and Tlahualilo

What is gypsum?



$CaSO_4 \cdot 2H_2O$

How is it formed?

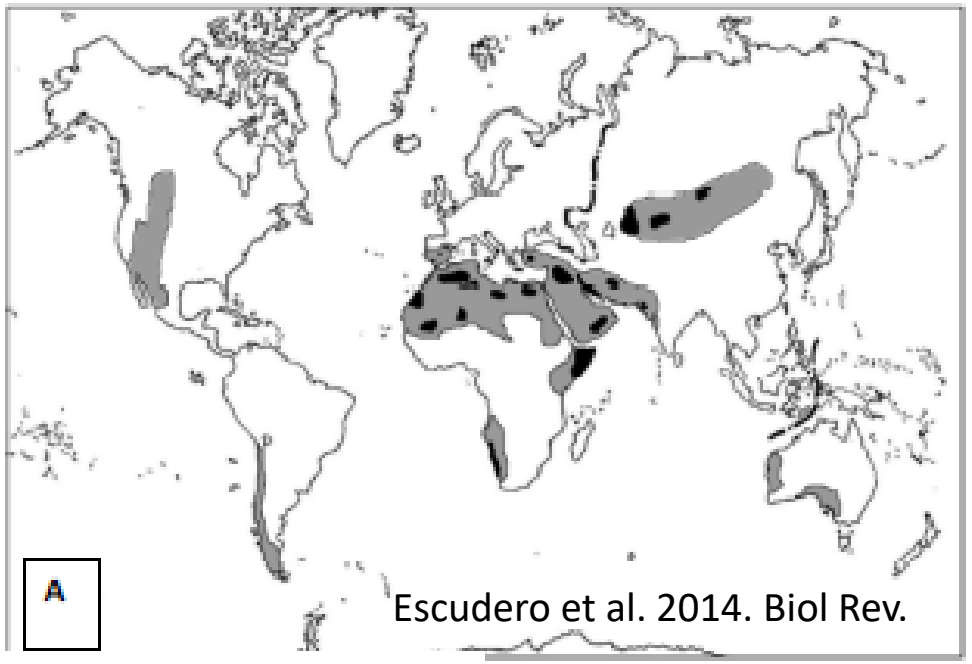


Urmia Lake, Iran

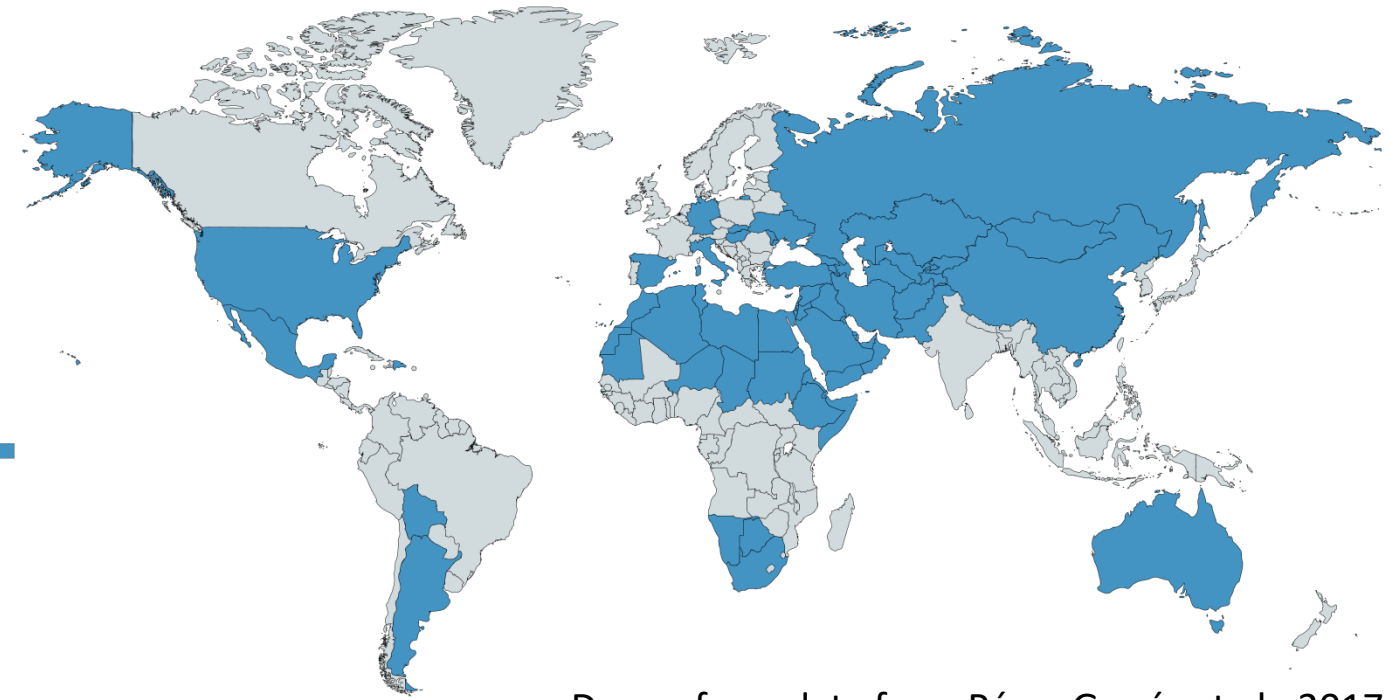
Gypsum in the world

207 Million Ha

48 countries with reported gypsophiles



Escudero et al. 2014. Biol Rev.

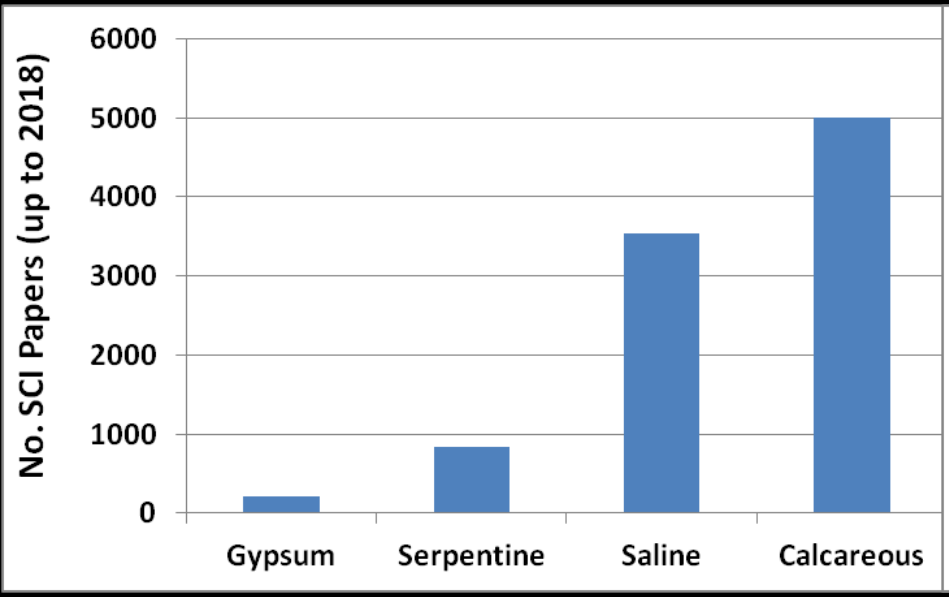


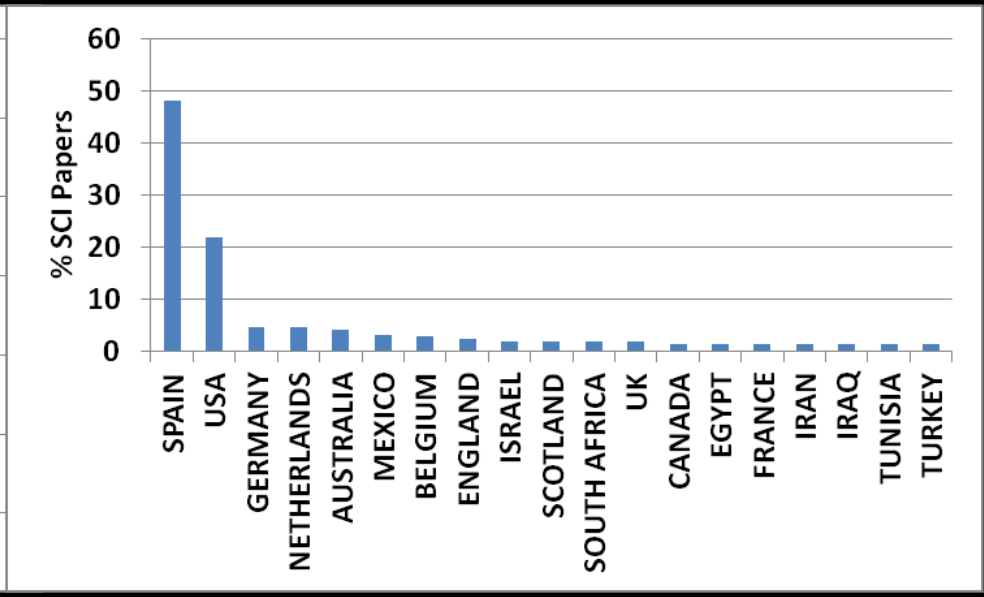
Drawn from data from Pérez García et al., 2017

75 % of the surface of the Middle East is affected by gypsum

In countries like Somalia, gypsum affects ca. 100% of the soil

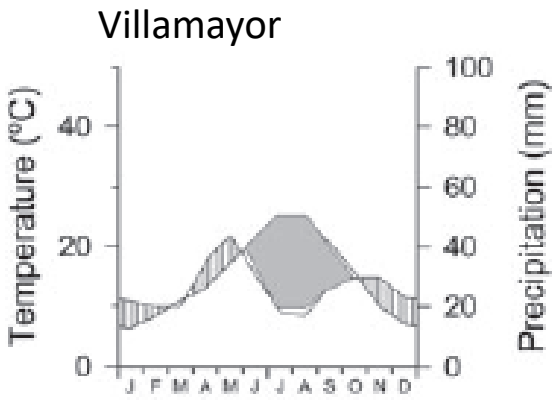
An understudied substrate

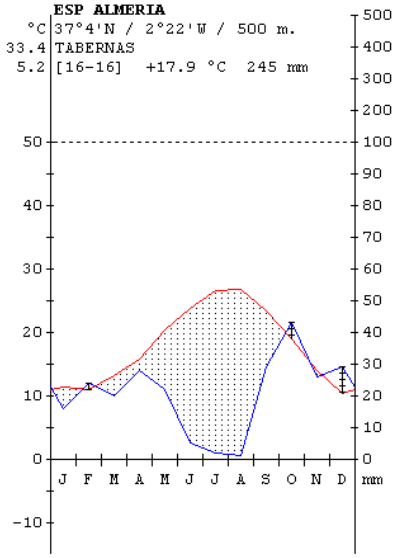




Particularly out of Spain…

Gypsum, a harsh substrate





Low rainfall

Hard surface crusts

	N (%)	P (mg 100 g^{-1})	K (mg 100 g^{-1})	Gypsum (%)	EC (dS m^{-1})
Min	0.01	0.7	0.2	0.1	0.4
Max	0.18	34.9	42.3	98.6	12.6
Average	0.06	5.3	13.2	41.9	3.2

Many sulphate

Many calcium

Nutrient poor

Moderate salinity

Romao & Escudero, 2005; Mota et al. 2011

Gypsum ecosystems, diversity hotspots

Just in Spain, 77 plant species are exclusive to gypsum, most of them are endemic

Limonium aragonense

Campanula fastigiata

50% of them have been identified as "threatened"

Mota et al. 2011

81 Iberian species of lichens (7 exclusive to gypsum)

107 species of mosses and liverworts

Most of these species should be protected

Gutiérrez-Carretero & Casares-Porcel, 2011; Salmerón et al. 2011

What do we know about gypsum ecosystems?

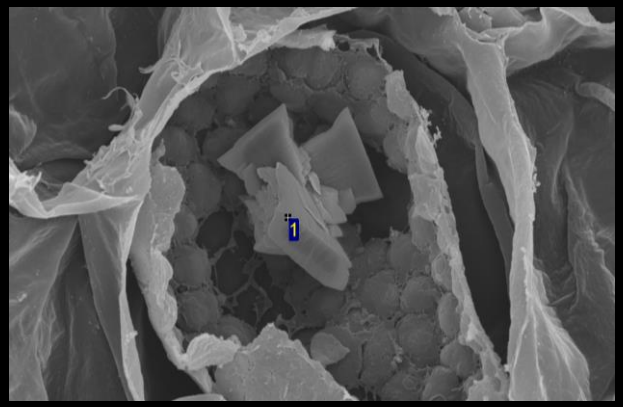
Topography and soil physical properties,

Plant-plant interactions,

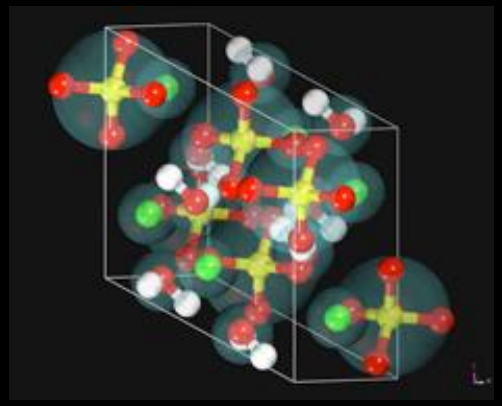
and plant-BSC interactions…

…are key determinants of the structure and dynamics of gypsum plant communities

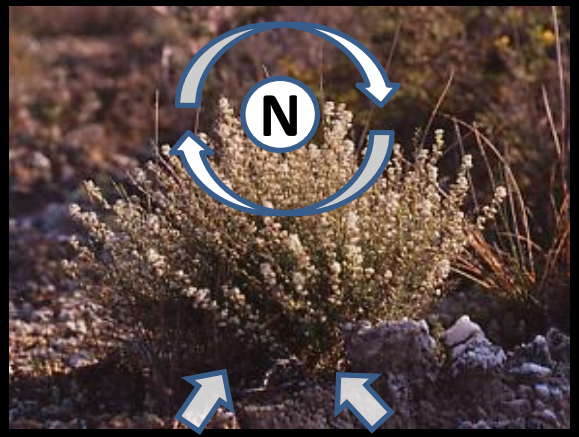
Plants have several mechanisms to cope with the typical limitations of gypsum soils

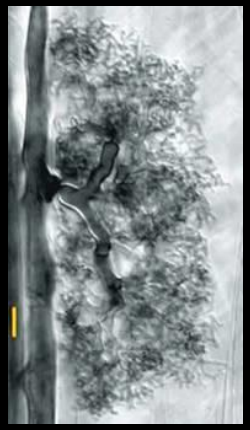


Accumulate excess SO_4 and Ca in a non-toxic way



Use all water sources available





Efficient uptake and re-cycling of nutrients, many times with the help of AMFs

The occurrence of some of these mechanisms is related to the phylogeny of plants

Old, widespread lineages of gypsum endemics tend to form gypsum crystals (Muller et al, 2017)

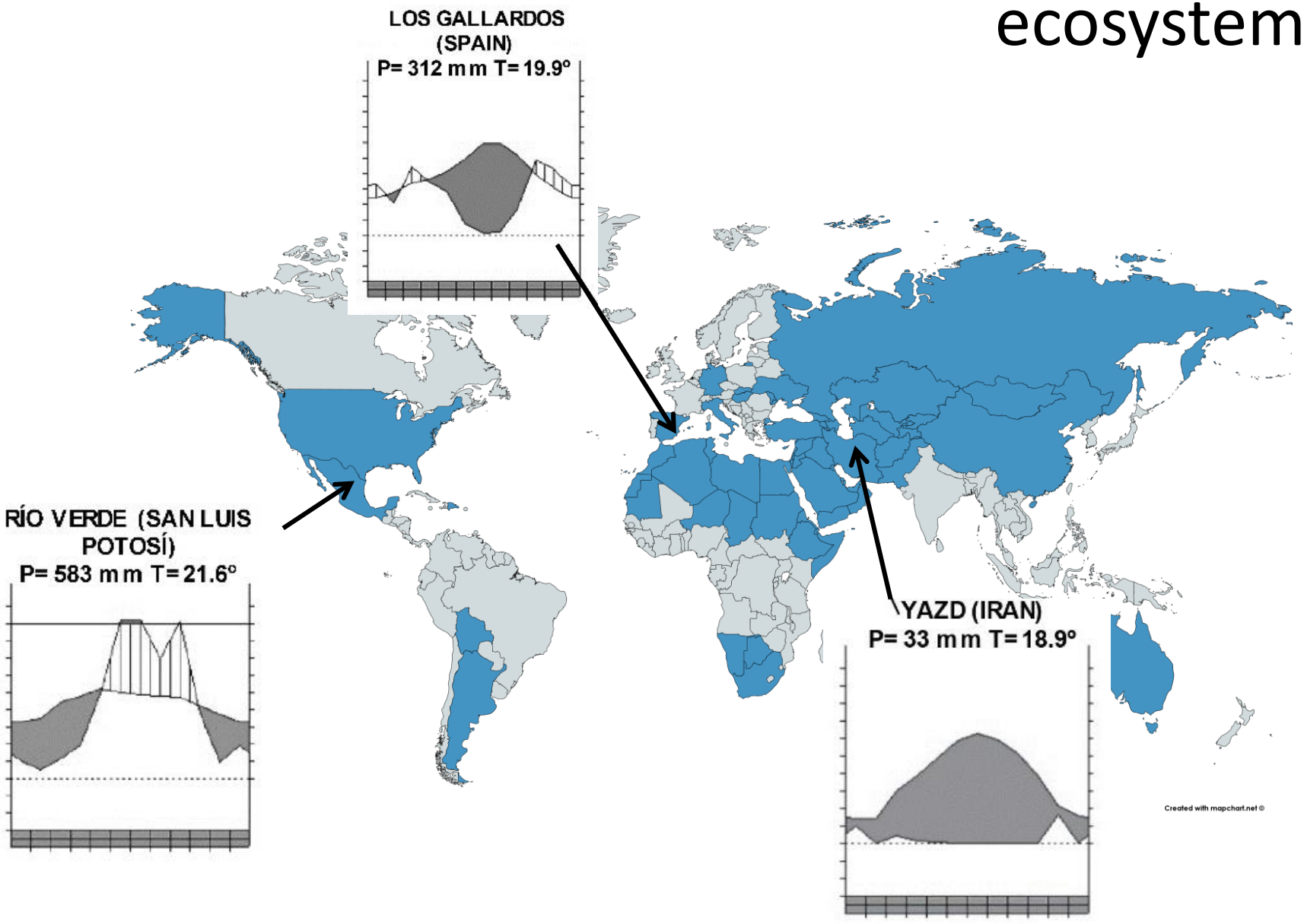
Young, narrowly distributed lineages of gypsum endemics show similar mechanisms to non-endemics (Muller et al, 2017)

Climate change, habitat fragmentation and habitat destruction severely threaten gypsum ecosystems



Some of the most damaging effects of global change can be ameliorated through ecological restoration of gypsum ecosystems


Can we apply this knowledge to other gypsum ecosystems?



The GYPWORLD project

General aim: perform an integrated, global study of the ecology and evolution of plant and lichen life on gypsum.

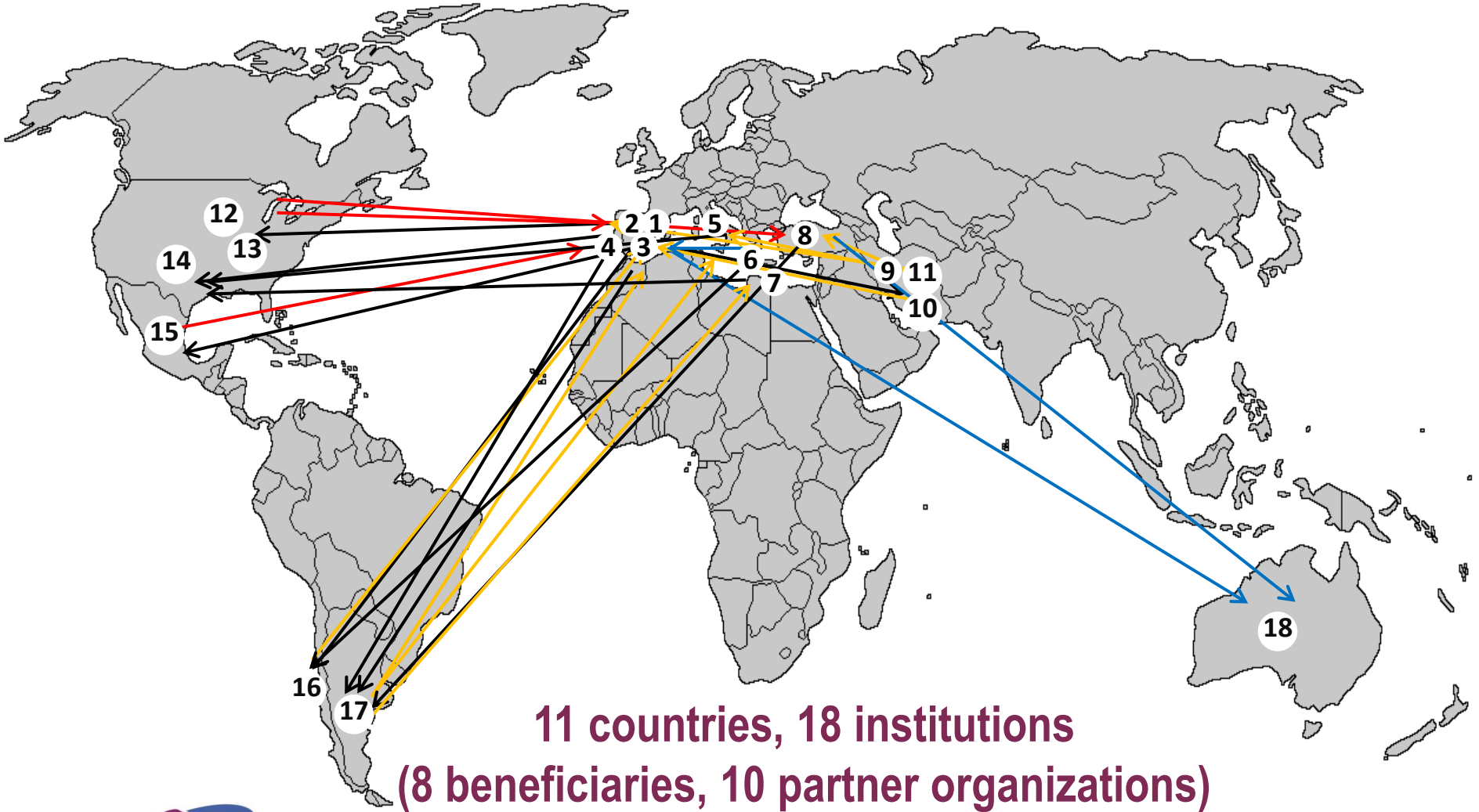
MARIE CURIE ACTIONS

European Commission

Horizon 2020
European Union funding
for Research & Innovation

Gypsum plant communities around the world may share similar adaptive mechanisms, evolutionary patterns, and ecological processes despite their independent evolutionary origins and distinct climates

The GYPWORLD project: consortium



11 countries, 18 institutions
(8 beneficiaries, 10 partner organizations)
> 60 researchers
164 Person/month (3 without funding)
724.500 € - 4 yr.

MARIE CURIE ACTIONS

European Commission | Horizon 2020 European Union funding for Research & Innovation

WP1.- Biodiversity – How diverse are gypsum ecosystems? (objective 1)

Species level

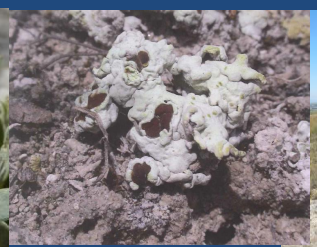
(Juan Mota – Isabel Martínez)

Creation of a preliminary global checklist of gypsophiles.

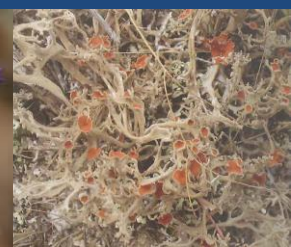
Community level

(Aran L. Luzuriaga – Gregorio Aragón)

Evaluate gypsum plant and lichen community diversity following a common protocol





WP2.- Origin and evolution of gypsum endemic floras (objective 2) – Coord: Miguel Verdú, Mike Moore, Pablo Vargas, María Prieto

What is the origin of gypsum endemic species?

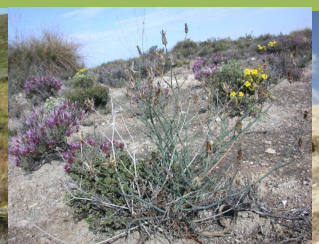
Did gypsophily evolve several times?

How does the evolution of gypsum lineages relate to key eco-physiological mechanisms to survive on gypsum?

Can we detect pre-adaptations to gypsum in plants?





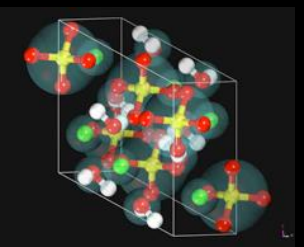
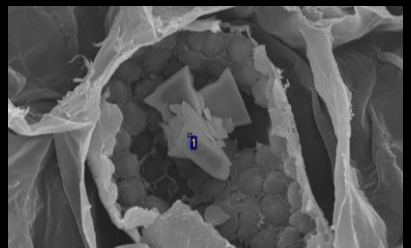



WP 3.- Functional ecology of gypsum ecosystems (objective 3)

Do gypsum plants from different floras and climates share common mechanisms to cope with the atypical chemical composition of gypsum soils ?

What is the functional structure of plant and lichen communities on gypsum ecosystems? Do they share common traits?

Are hydraulic properties of soils and plants, plant-plant interactions, plant water use and nurse effects common across gypsum ecosystems?


WP 4.- Response and mitigation of global change effects (objective 4)

What effects do global change drivers (warming, drought and overgrazing) have on gypsum plant communities?

Inform on best practices to mitigate the negative effects of global change on gypsum plant ecosystems through ecosystem restoration.

Evaluate the degree of protection and vulnerability of gypsum plant communities globally.

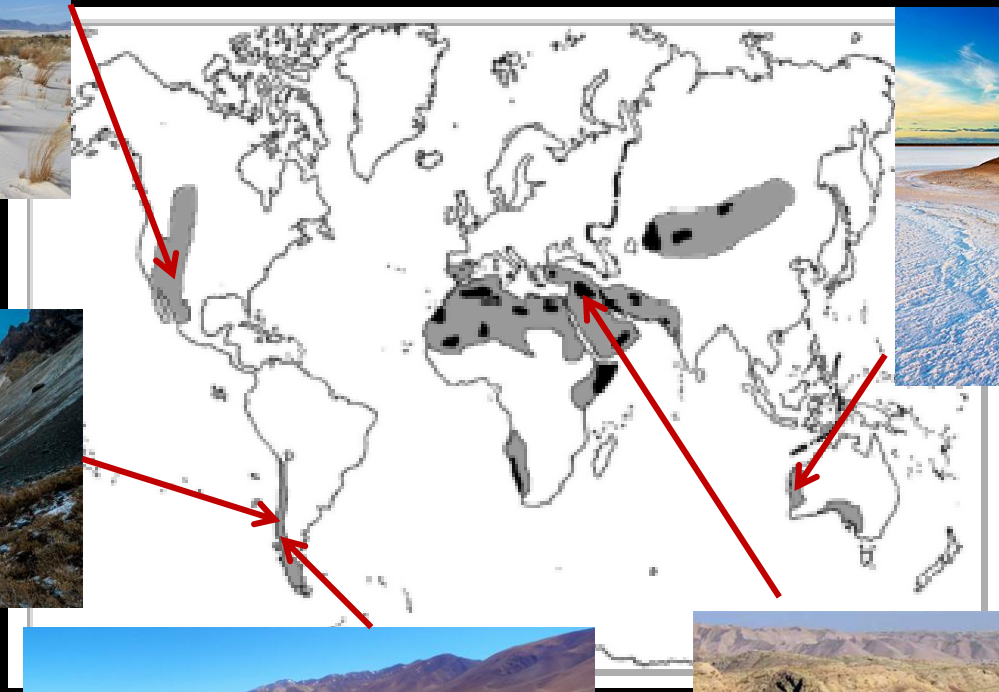




GYPWORLD project: Expeditions planned

USA 2018 & 2019

Chile 2018



Australia 2019 & 2020

Argentina 2018

Iran 2018 & 2020

GYPWORLD project: Training and Networking actions

Type of event	May 2018 (Ankara - Turkey)	Apr 2019 (Sicily - Italy)	Mar 2020 (Nicosia- Cyprus)	Nov 2021 (Almería- Spain)
Workshops	Biodiversity	Functionality	Global Change	Restoration
Conferences	1st GER Conference		2nd GER Conference	
Courses	-Gender Balance - Analysis of phylogenies	- Functional Traits	- Lichens and BSCs	- Effective communication

Open to the whole scientific community and free of charge

Reggio di Calabria-Sicily 2019

April, 2019

2nd GYPWORLD Workshop

Functioning of gypsum ecosystems

Università degli Studi Mediterranea di Reggio Calabria


Feel inspired?
New global studies on gypsum ecosystems are welcome!

THANKS!

Contact: s.palacio@ipe.csic.es