

HOW MANY GYPSOPHYTES ARE THERE?

A DELPHI APPROACH FOR SPAIN



Juan F. Mota Dpt. Biology and Geology University of Almería (Spain)

<u>jmota@ual.es</u>









What was the first unambiguous reference to unusual soils flora (in the world)?

"Quarta fruticosior, & brevior provenit in nudis saxosis, copiosa in Montacuto, juxta lapidem nigrum; quod multum Amianti nigri complectitur: in alia terra reperire non licet hanc herbam" (De plantis, 1583)



Image from: Robinson, B. H. (1997). The phytoextraction of heavy metals from metalliferous soils



June 3-9, 2018 Ankara/Turkey

1



In Spain there is a long tradition in the study of gypsum flora ... 3

Asso (1779) Synopsis stirpium indigenarum Aragoniae.

"... ubi gypsum adest".

SYNOPSIS

STIRPIUM INDIGENARUM

AR AGONIAE.

CÆSARAUGUSTANO.

EST IGITUR COGNITIO NATURALIS patriæ præferenda exterarum regionum

Acad. Vol. I. pag. 1.

MASSILLE M.DCC.LXXIX.

AUCTORE C. A. R. (Ignatine d'asto)

Cavanilles (1795-1797).

He refers to the gypsum flora and mentions the scaly xara, ononide tridentata and Herniaria fruticosa.

> OBSERVACIONES SOBRE LA HISTORIA NATURAL, GEOGRAFIA, AGRICULTURA, POBLACION Y FRUTOS DEL REYNO DE VALENCIA. DON ANTONIO JOSEF CAVANILLES.



DE ORDEN SUPERIOR. EN MADRID, EN LA IMPRENTA REAL, NO DE 1795.

After Cavanilles there is at least one reference to this flora before Willkomm and that was made by Boissier (1839-1845).

"Nothing is more desolate than the look of these barren sites completely deprived of fresh water".





VOYAGE BOTANIQUE

LE MIDI DE L'ESPAGNE

PENDANT L'ANNÉE 1837,

EDMOND BOISSIEB

condite of order of second in on other states of the

TOMET

NARRATION ET GEOGRAPHIE BOTANIQUE



PARIS. GIDE ET C*, LIBRAIRES-EDITEURS

1820-1845.

5 The Iberian steppes of Willkomm

Strand- und Steppengebiete

Die

Iberischen Halbinsel

und deren Vegetation.

Ein Beitrag zur physikalischen Geographie, Geognosie und Botanik

> Dr. Moritz Willkomm, Privablocenten se der Leiversität zu Leipzig.

von

9

Nebst einer geognostisch-botanischen Karte der Halbinsel, einer Stein- und einer Kupfertafel.

> Leipzig, Friedrich Fleischer. 1852.









			Gypsophily	The spreading of gypsophili
. Ye	ear	Author/s	Contribution	
17 17	795- 797	Cavanilles	Referring to the gypsum flora, he mentions the 'xara escamosa' or 'xara con escamas', 'ononide tridentata' or 'ononide de tres dientes' and <i>Herniaria fruticosa</i>	spain XVIII
18 18	839- 845	Boissier	This author speaks about the peculiarity of the Iberian gypsum outcrops (and salt terrains) as far as their vegetation is concerned, and mentions some territories in which they can be found: central Spain, the two <u>Castiles</u> , Aragon, Catalonia, <u>Alhama</u> de Granada, plains of <u>Guadix-Baza</u> and <u>Marquesado</u> . He mentions up to 10 plants peculiar to these substrates, e. g., <u>Gypsophila</u> <u>struthium</u> , <u>Centaurea</u> <u>hyssopifolia</u> , <u>Vella</u> <u>pseudocytisus</u> or <u>Boleum</u> <u>asperum</u> .	<u>X!X</u>
18	852	Willkomm	In his work about the Iberian steppes, he not only provides a detailed mapping of them, but also mentions over 30 taxa peculiar to gypsum outcrops. Examples of these are: <u>Centaurea hyssopifolia</u> , <u>Frankenia thymifolia</u> , <u>Gypsophila hispanica</u> , <u>G. struthium</u> , <u>Helianthemum squamatum</u> , <u>Herniaria fruticosa</u> , <u>Jurinea pinnata</u> , <u>Lepidium subulatum</u> , <u>Santolina viscosa</u> , <u>Vella pseudocytisus or Zollikoferia (Launaea) pumila</u> .	
18	881	<u>Contejan</u>	He is one of the first researchers dealing with the impact of gypsum on flora and vegetation. He comments on the fact that in France the gypsum outcrops are <u>unfrequent</u> and they are often mixed with marls. His observations lead him to think that the impact of gypsum on plants does not significantly differ from that of limestone.	France
18	883	Odón de <u>Buén</u>	In his work he stresses the relationships between plants and the soils they grow on. He acknowledges a dozen of plants exclusive to gypsum outcrops. Among these he mentions <i>Gypsophila struthium, G. hispanica, Lepidium subulatum, Frankenia thymifolia, Ononis tridentata</i> or <i>Helianthemum squamatum</i> . He distinguishes the 'cerros yesosos' ['gypsum hills'] as a subtype of steppes.	
18 18 18	888 891 892	Macchiati	After studying the flora growing on the gypsum outcrops of <u>Regio</u> Emilia (Italy), re refutes <u>Contejan's</u> view and states that gypsum actually has an impact on the floristic composition of vegetation, not as much because of its chemical and mineralogical composition, but because of its physical features and mechanical <u>disgregation</u> .	italy
18	898	Cockerell & García	Although their work concentrates on the role of gypsum as fertilizer, they also provide some edaphic data on the White Sands (USA), in particular, the high proportion of calcium sulphate.	
19	903	Coville & Mac Dougal	The authors describe the vegetation of White Sands and provide data on the composition of dunes with over 90% of gypsum.	USA XX
19	907	Lázaro Ibiza	In the chapter on botanical geography he briefly deals with the steppes in a paragraph and states that they are exclusively associated with salt environments.	
19	915	Reyes <u>Prósper</u>	He is the first author who uses the term ' <u>vipsófila' [gypsophilous]</u> . His detailed mapping of the Iberian steppes distinguishes three large types. However, it is difficult to say that gypsum outcrops correspond to any of them.	Weiß, Die Gipsflora des Südharzes
19	923	Weiss	He fails to identify exclusive floristic elements, but he actually identifies some <u>xerophilous</u> elements, sometimes of a relict character.	Germany
1	1st	GYPSUM EC	OSYSTEM RESEARCH CONFERENCE June 3-9	9, 2018 Ankara/Turkey 🚫

Personally, I am very interested in ...





Table 6.2 Some edaphic and biological factors influencing ultramafic, dolomitic and gypsum soils

Factors			Se	Do	Gy
Soil physical	Water relations	***	***	**	
factors	8882 -	Very drained soils, with gravel and sand predominance	**	***	-
	CERTS I	Soils with irregular porosity and poorly aerated	-	-	**
i i i	2° 6 6 2 2	Low water conductivity	-	-	***
	Crusts and physical impediments	Edaphic crusts and cemented soil horizons	-	*	***
		Upholstering biological crusts (mainly lichens)	-	-	***
	Soil-forming factors	Prevalence of erosive processes	**	***	**
	Topography	Unfavorable orientation, steep and exposed crests	**	***	***
Soil chemical factors	Nutrients shortage	Limited macronutrients availability (P > N >> K)	**	**	***
7	Calcium-magnesium relationship	Ca:Mg antagonism	***	**	**
		Ca deficiency	***	*	-
sor its		Mg deficiency	-	-	*
		Mg excess (toxicity)	***	**	-
	Toxicity	Heavy metals (Ni > Cr > Cd)	***	-	-
- Constant		S and Ca excess	-	*	***
Biological factors	Evolutionary trajectory and phylogeny	Pre-adaptation and cross-tolerance	**	*	***
	Biological pedogenesis	Slow and poor biological processes	***	***	***
109	Root symbiosis	Mycorrhiza, Rhizobium	**	**	**
	Plant-plant interactions	Relaxed interspecific competition and strong resistance to invasive species	**	***	***
		Facilitation (nursery plants)	*	?	**
		Alellopathy	?	?	*
	Biofilms	Enhanced soil fertility and stability by biofilm traps	*	*	***

Responsible factors for edaphism. Se serpentine, Do dolomite, Gy gypsum Heft ***high, **moderate, *low, - null, ? no evidence June 3-9, 2018 Ankara/Turkey 🍋

10 How do we find a true gypsophile? (Drohan & Merkler, 2009)

Criterion	Justification
Inductive criterion	Species always or almost always recorded as growing on gypsum outcrops / soils. With accurate measurements, this criterion can also become a statistical criterion.
Expert criterion	Species which experts well acquainted with the gypsophilous or gypsophile flora deem as associated to gypsum outcrops.
Bibliographical criterion	Species mentioned in technical literature as being peculiar to gypsum outcrops.
Syntaxonomical criterion	Diagnostic or characteristic species of syntaxa peculiar to gypsum outcrops (<i>Gypsophiletalia</i> , <i>Sedo-Ctenopsion</i> ,).
Bioindicator criterion	Plant which occur or tend naturally to occur with undoubtedly gypsophilous species ("ultra-gypsophytes").
Edaphic criterion	<i>Taxa</i> which grow on soils with a high gypsum (or Ca ^ S) content. Gypsisols?
Ecophysiological criterion	Presence of morphoanatomical or physiological adaptations as a result of growing on gypsum outcrops.
Evolutive criterion	Molecular markers indicating gypsophily.
Criteria which have be	en or can been used to determine whether or not a plant is a gypsophile species.

CRITERIA

10

LUDIO.

EC dS m⁻¹

Lazaroa	
ISSN: 0210-9778	

http://dx.dol.org/10.5209/LAZA.54044

psocline

Conceptual baseline for a global checklist of gypsophytes

Juan F. Mota¹, Juan Antonio Garrido-Becerra¹, Francisco Javier Pérez-García¹, Esteban Salmerón-S Pedro Sánchez-Gómez² & Encarna Merlo¹

> 1.- Gypsum-tolerance vs gį 2.- Terminology 3.- What is a gypsiferous s



... "known or presumed tolerance to electrical conductivity measuring (or estimated to be) at least 7.8 dS m⁻¹, during significant periods of the plant's entire life".

EDICIONI COMPLU

Obligate Gypsophile Wide Gypsophile June 3-9, 2018 Ankara/Turkey



¹² Plant taxa found only on soils containing gypsum have been referred to as obligate gypsophiles (Johnston, 1941) - Parsons 1976



IST GYPSUM ECUSYSTEM RESEAKCH

	JOURNAL								
	OF THE								
AR	NOLD ARBORETU	JM							
Vol. XXII	APRIL, 1941	Number 2							
GYPSOPHILY AMONG MEXICAN DESERT PLANTS Ivan M. Johnston									
to gyps	eous areas	1							

June 3-9, 2018 Ankara/Turkey 🌕

Associated with the species that have spread on to gypseous areas from surrounding non-gypseous soils is the much smaller group of species which are never found beyond the margins of gypseous areas of soil. The most abundant and successful plants found on gypsum exposures commonly belong to this smaller second group of plants.





FLORA

www.elsevier.de/flora

CLORA REVIEW

olomite flora of the Baetic Ranges glades (South Spain)

Francisco Mota^{a,*}, José Miguel Medina-Cazorla^a, Francisco Bruno Navarro^b, Javier Pérez-García^a, Andrés Pérez-Latorre^c, Pedro Sánchez-Gómez^d, To Torres^e, Alfredo Benavente^f, Gabriel Blanca^g, Carlos Gil^h, Juan Lorite^g, Incarnación Merlo^a

nent of Biología Vegetal y Ecología, Universidad de Almería, E-04120 Almería, Spain e Ststemas Forestales, Área de Recursos Naturales, Centro de Investigación y Formación Agraria (IFAPA, CICE-Junta An Junia), Camino de Purchil sh., Aptido 2027, Granada, Spain Department of Biología Vegetal, Universidad de Malaga, Apdo. 59, E-29080 Málaga, Spain Department of Biología Vegetal, Universidad de Marcía, E-30071 Murcía, Spain Ospartment of Biología Vegetal, Universidad de Marcía, E-30071 Jun, Spain onsejería de Medio Ambiente, Junta de Andalucio mento de Josto Jone, Spain estructura de Jonina Agricola de Jesolution do Jonina, Vegetal y Cología, Universidad de Jane, Spain Structura de Biología Almería, Universidad de Grano Sento C. Jogía y Quínica Agricola de Jesolution do Jonina Agricola de Jesolution do Jonina Agricola Marcía, E-2012/0, pria, Spain

Methods in Ecology and Evolution

Methods in Ecology and Evolution 2015, 6, 1097–1109

doi: 10.1111/2041-210X.12387

The Delphi technique in ecology and biological conservation: applications and guidelines

Nibedita Mukherjee^{1,2,3}*, Jean Hugé^{3,4}, William J. Sutherland¹, Jeffrey McNeill⁵, Maarten Van Opstal^{3,6,7}, Farid Dahdouh-Guebas^{2,3,†} and Nico Koedam^{2,†}



The Delphi technique is a method used for enabling a group of individuals to collectively address a complex problem through a structured group communication process



15 Geographical distribution of the experts taking part in the analysis in Spain



number of taxa = 223 number of experts = 43 expert judgment = 4157 experts mean judgements (taxa) = 97 (43,5%)





|--|

Taxón	MED	MDN	VAL	MAX	MIN
Lepidium subulatum	4,91	5	43	5	4
Teucrium libanitis	4,88	5	12	5	4
Helianthemum squamatum	4,87	5	41	5	3
Helianthemum alypoides	4,85	5	26	5	4
Chaenorhinum reyesii	4,83	5	18	5	4
Chaenorhinum exile	4,79	5	14	5	3
Gypsophila struthium subsp. struthium	4,77	5	33	5	3
Gypsophila struthium subsp. hispanica	4,69	5	29	5	4



Lepídíum subulatum



Teucríum líbanítís



Helíanthemum squamatum



Helíanthemum alypoídes G. struthíum subsp. híspaníca Gypsophíla struthíum subsp. struthíum

Chaenorrhínum reyesíí

Chaenorrhínum exíle







Some zeroing species: the judges, judged 20



Aphyllanthes monspeliensis

Ю

Cístus clusíí

Erínacea anthyllís



21 Scholars in family or scholars families?





22 The North vs the South



Herníaría frutícosa Launaea fragílís Arenaría cavaníllesíana Thymus loscosíí Euzomodendron bourganum Thymelaea hírsuta

Species:

23 Some minor discrepancies





June 3-9, 2018 Ankara/Turkey 🌅

-



June 3-9, 2018 Ankara/Turkey 🌅











27 Some minor discrepancies

Euzomodendron bourgeanum



28 What happened with the zeroing species?

rated an hour ago CopenStreetMap contributors,

https://www.gbif.org/species/2770868

Aphyllanthes monspeliensis



29 Scholars under scrutiny ... again





31 To be or not to be ...

 Helianthemum syriacum (Jacq.) Dum. Cours. (Fam. Cistaceae) y táxones infraespecíficos

Helianthemum syriacum



32 In any case, the king is still king





Lepidium subulatum

5,0			5,0	5,0	5,0		5,0	5,0	5,0	5,0	5,0	5,0	
	4,9												
4.6													
-,•													
MEAN							MEC	DIAN					

T1 T2 T3 T4 T5 T6

33 What aspects are key when making an inventory of gypsophytes using the Delphi method?

Taxón	MED	MDN	VAL	MAX	MIN
Lepidium subulatum	4,91	5	43	5	4
Teucrium libanitis	4,88	5	12	5	4
Helianthemum squamatum	4,87	5	41	5	3
Helianthemum alypoides	4,85	5	26	5	4
Chaenorhinum reyesii	4,83	5	18	5	4
Chaenorhinum exile	4,79	5	14	5	3
Gypsophila struthium subsp. struthium	4,77	5	33	5	3
Gypsophila struthium subsp. hispanica	4,69	5	29	5	4
Teucrium turredanum	4,67	5	24	5	3
Centaurea hyssopifolia	4,63	5	15	5	2
Orobanche georgii-reuteri	4,58	5	6	5	3,5
Campanula fastigiata	4,58	5	37	5	2
Ononis tridentata subsp. crassifolia	4,53	5	20	5	2
Teucrium lepicephalum	4,50	5	12	5	3
Teucrium pumilum	4,45	5	11	5	2
Helianthemum marifolium subsp. conquense	4,43	5	7	5	3
Teucrium balthazaris	4,39	5	18	5	2
Limonium viciosoi	4,38	4,75	4	5	3
Thymus lacaitae	4,54	4,5	13	5	4

1. The judgments of the experts should only be about species they know very, very well.

2.- If possíble, avoid territorial bíases

3.- It is important to try to statistically evaluate the results.



GYSOPHYTES GYPSOCLINES GYPSOVAGS June 5-9, 2010 Allkara/Turkey

34 Strengths...



 The experts are generous and very participative
The opinions of the experts on the procedure help to improve the method.

3.- The experts know very ínteresting places



How can a checklist help us?





36 Establishing a network of protected areas





To enhance our scientific knowledge



Astragalus castroviejoi

Orobanche gypsogena

Chaenorrhínum gamezíí





38







42 Lapís specularis, the crystals of the Empire











Thank you for your attention

1st gypsum ecosystem research



Thanks to the Torralba Group for its financial support through the <u>ECORESGYP</u> project