Supplementary Information

Rhizospheric Cyanoprokaryota Influence Nutrient Availability and Gypsophyte Adaptation in Semiarid Gypsiferous Soils

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Table S1. Multivariate test for overall significance of discrimination (a), tests of residual roots (b) and classification results (c) for the scenarios **A** (Non-rhizospheric and rhizospheric soil properties and elements) and **B** (Rhizospheric soil properties and elements).

A Non-rhizospheric and rhizospheric soil properties and elements

a)Test the null hypothesis of equal population covariance matrices							
analysis case processing summary (valid): 89.6 %							
N. of variables			44				
M of Box			96.611				
Approximate F ratio			2.576				
Degrees of freedom			[30; 3221.808]				
P value			< 0.001				
b) Tests of the residual roots							
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	4.358	72.5	72.5	0.902	0.063	105.182	12	< 0.001
2	1.425	23.7	96.2	0.767	0.336	41.397	6	< 0.001
3	0.226	3.8	100.0	0.429	0.816	7.729	2	0.021
c) Classification results. Original pooled cases correctly classified: 77.1 % Predicted group membership:							
0= 58.3 %			1=Hf= 66.7 %		2=Hl=91.7%		3=Tl= 91.7%

B Rhizospheric soil properties and elements

a)Test the null hypothesis of equal population covariance matrices							
analysis case processing summary (valid): 97.2 %							
N. of variables			44				
M of Box			72.760				
Approximate F ratio			1.862				
Degrees of freedom			[30; 3195.289]				
P value			0.003				
b) Tests of the residual roots							
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	3.900	58.6	58.6	0.892	0.054	87.384	10	< 0.001
2	2.756	41.4	100.0	0.857	0.266	39.704	4	< 0.001
c) Classification results. Original pooled cases correctly classified: 91.7 % Predicted group membership:							
			1=Hf= 83.3 %		2=Hl=100 %		3=Tl= 91.7%

Table S2. Multivariate test for overall significance of discrimination (a), tests of residual roots (b) and classification results (original and predicted group) (c). 0=non-rhizospheric soil, 1=Hf=*H. fruticosa*, 2=Hs=*H. squamatum*, 3=Tl=*T. libanitis*, and 4=Mc= *M. chthonoplastes* for the scenarios **A** (Rhizospheric and non-rhizospheric soils and *M. chthonoplastes),* **B** (Leaves of gypsophytes and *M. chthonoplastes*) and **C** (Roots of gypsophytes and *M. chthonoplastes*).

A Rhizospheric and non-rhizospheric soils and *M. chthonoplastes*

a)Test the null hypothesis of equal population covariance matrices								
analysis case processing summary (valid): 100 %								
N. of variables				16				
M of Box				612.602				
Approximate F ratio				6.944				
Degrees of freedom				[45; 990.117]				
P value				< 0.001				
b) Tests of the residual roots								
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	51032.314	100	100	1.000	0.000	261.922	20	< 0.001
2	1.856	0	100	0.806	0.345	23.437	12	0.024
3	0.016	0	100	0.125	0.984	0.348	6	0.999
4	0.000	0	100	0.011	1.000	0.003	2	0.999
c) Classification results. Original pooled cases correctly classified: 77 % Predicted group membership:								
0= 83.3 % 1=Hf= 66.7 % 2=Hs=83.3% 3=Tl= 50 % 4=Mc=100 %								

B Leaves of gypsophytes and *M. chthonoplastes*

a)Test the null hypothesis of equal population covariance matrices								
analysis case processing summary (valid): 59.6 %								
N. of variables				18				
M of Box				121.943				
Approximate F ratio				3.090				
Degrees of freedom				[30; 3001.074]				
P value				< 0.001				
b) Tests of the residual roots								
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	7.304	68.9	68.9	0.938	0.028	103.707	10	< 0.001
2	3.303	31.1	100.0	0.876	0.232	42.321	4	< 0.001
c) Classification results. Original pooled cases correctly classified: 89.7 % Predicted group membership:								
1=Hf= 100 % 2=Hl=100 % 3=Tl= 100 % 4=Mc=58.8 %								

C Roots of gypsophytes and *M. chthonoplastes*

a)Test the null hypothesis of equal population covariance matrices	
analysis case processing summary (valid): 60 %	
N. of variables	22
M of Box	46.698
Approximate F ratio	3.372
Degrees of freedom	[12; 5277.462]
P value	< 0.001
b) Tests of the residual roots	

DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	6.274	78.8	78.8	0.929	0.051	95.127	6	< 0.001
2	1.687	21.2	100.0	0.792	0.372	31.631	2	< 0.001
c) Classification results. Original pooled cases correctly classified: 82.5 % Predicted group membership:								
1=Hf= 75 % 2=Hl=100 % 3=Tl= 100 % 4=Mc=55 %								

Table S3. Multivariate test for overall significance of discrimination (a), tests of residual roots (b) and classification results (original and predicted group) (c) for the scenarios A (Rhizospheric soils of gypsopytes and leaves and roots), B (B Leaves and roots from gypsophytes) and C (Leaves from gypsophytes).

A Rhizospheric soils of gypsopytes and leaves and roots

a)Test the null hypothesis of equal population covariance matrices								
analysis case processing summary (valid): 91.7 %								
N. of variables				66				
M of Box				209.695				
Approximate F ratio				1.731				
Degrees of freedom				[72; 2390.629]				
P value				< 0.001				
b) Tests of the residual roots								
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	36.294	73.2	73.2	0.987	0.002	166.421	16	< 0.001
2	13.314	26.8	100.0	0.964	0.070	70.522	7	< 0.001
c) Classification results. Original pooled cases correctly classified: 91.7 % Predicted group membership:								
1=Hf= 100 % 2=Hl=100 % 3=Tl= 91.7 %								

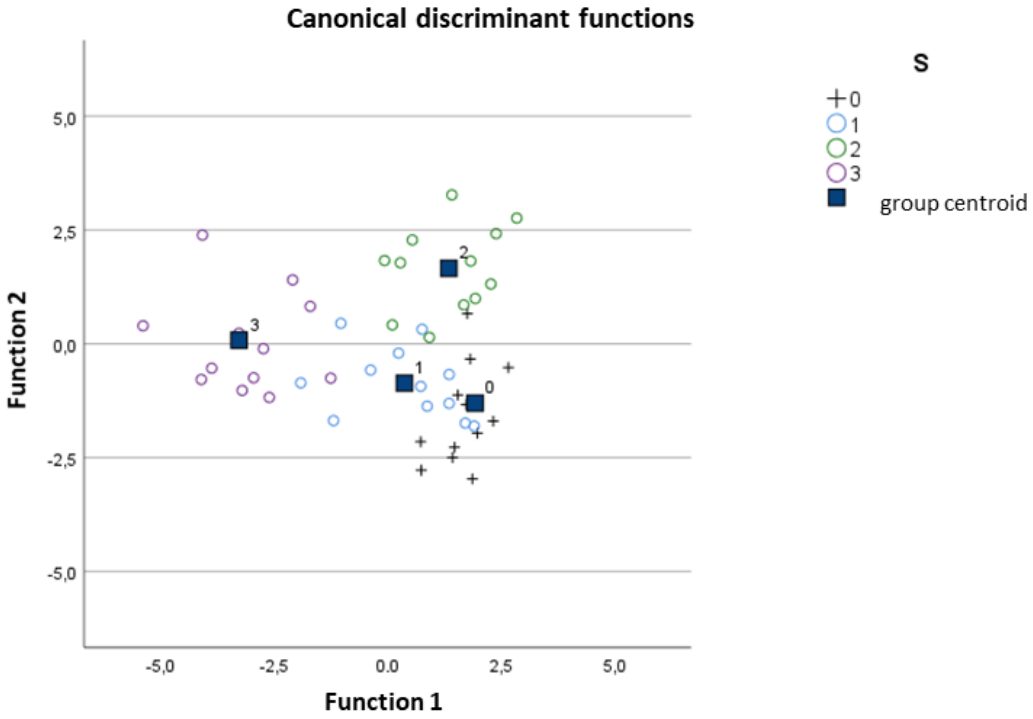
B Leaves and roots from gypsophytes

a)Test the null hypothesis of equal population covariance matrices								
analysis case processing summary (valid): 94.4 %								
N. of variables				44				
M of Box				199.574				
Approximate F ratio				1.682				
Degrees of freedom				[55; 1398.327]				
P value				0.002				
b) Tests of the residual roots								
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	34.830	66.6	66.6	0.986	0.002	172.134	20	< 0.001
2	17.483	33.4	100.0	0.973	0.054	77.296	9	< 0.001
c) Classification results. Original pooled cases correctly classified: 97.1 % Predicted group membership:								
1=Hf= 100 % 2=Hl=100 % 3=Tl= 97.1 %								

C Leaves from gypsophytes

a)Test the null hypothesis of equal population covariance matrices								
analysis case processing summary (valid): 70.8 %								
N. of variables			22					
M of Box			165.164					
Approximate F ratio			1.951					
Degrees of freedom			[56; 2706.358]					
P value			< 0.001					
b) Tests of the residual roots								
DF	Eigen value	Eigen (%)	Eigen cum	Canon. R	Wilks´s ƛ	Chi^2	df	p value
1	12.366	62.8	62.8	0.962	0.009	131.916	14	< 0.001
2	7.319	37.2	100.0	0.938	0.120	59.320	6	< 0.001
c) Classification results. Original pooled cases correctly classified: 100 % Predicted group membership:								
1=Hf= 100 % 2=Hl=100 % 3=Tl= 100 %								

A


Canonical discriminant functions
S
0
1
2
3
group centroid
5,0
2,5
0,0
-2,5
-5,0
Function 2
-5,0
-2,5
0,0
2,5
5,0
Function 1

B

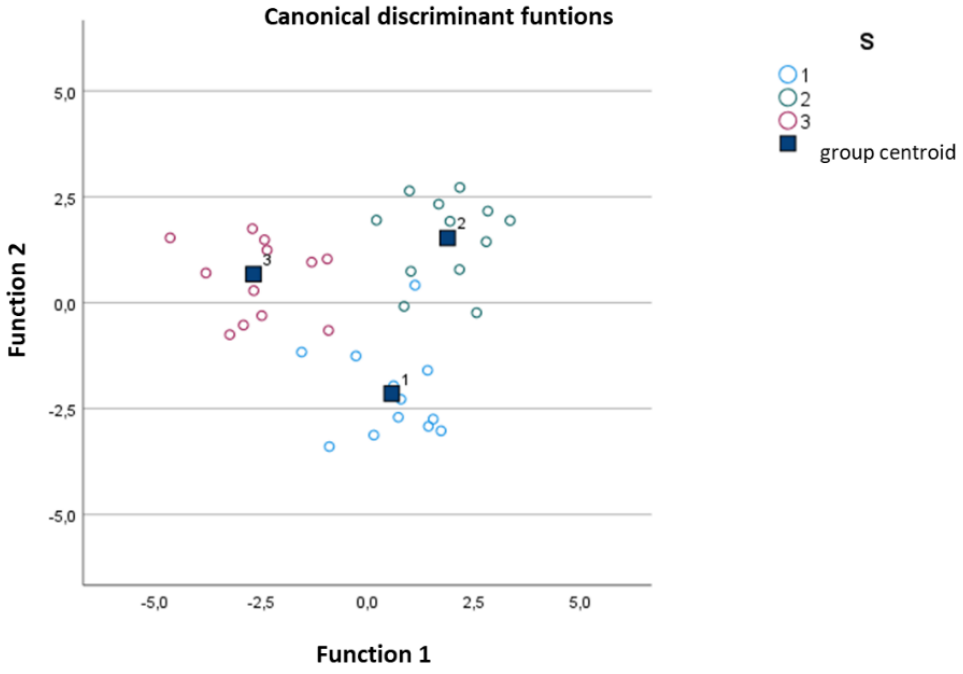
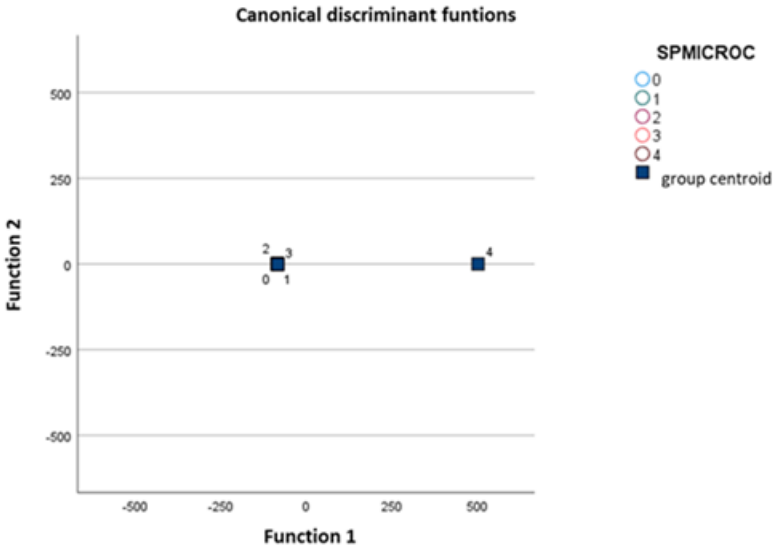
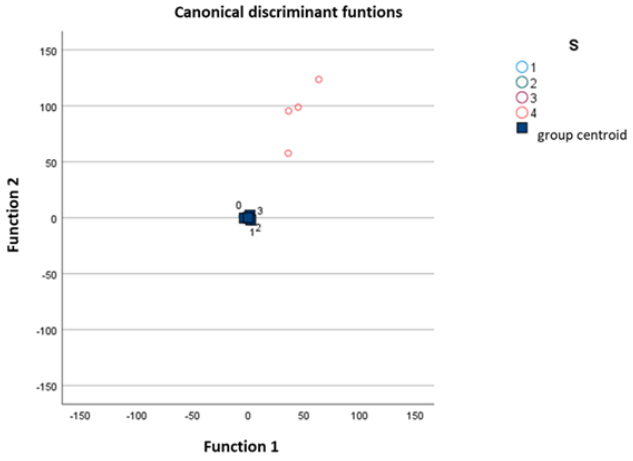

Canonical discriminant funtions
S
1
2
3
group centroid
5,0
2,5
0,0
-2,5
-5,0
Function 2
-5,0
-2,5
0,0
2,5
5,0
Function 1

Figure S1

A



B



C

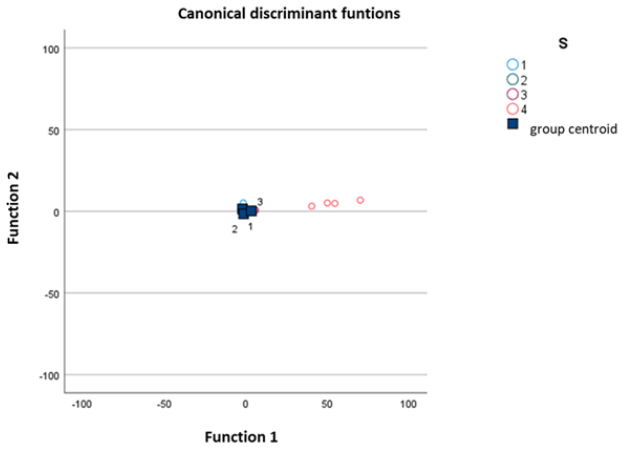


Figure S2

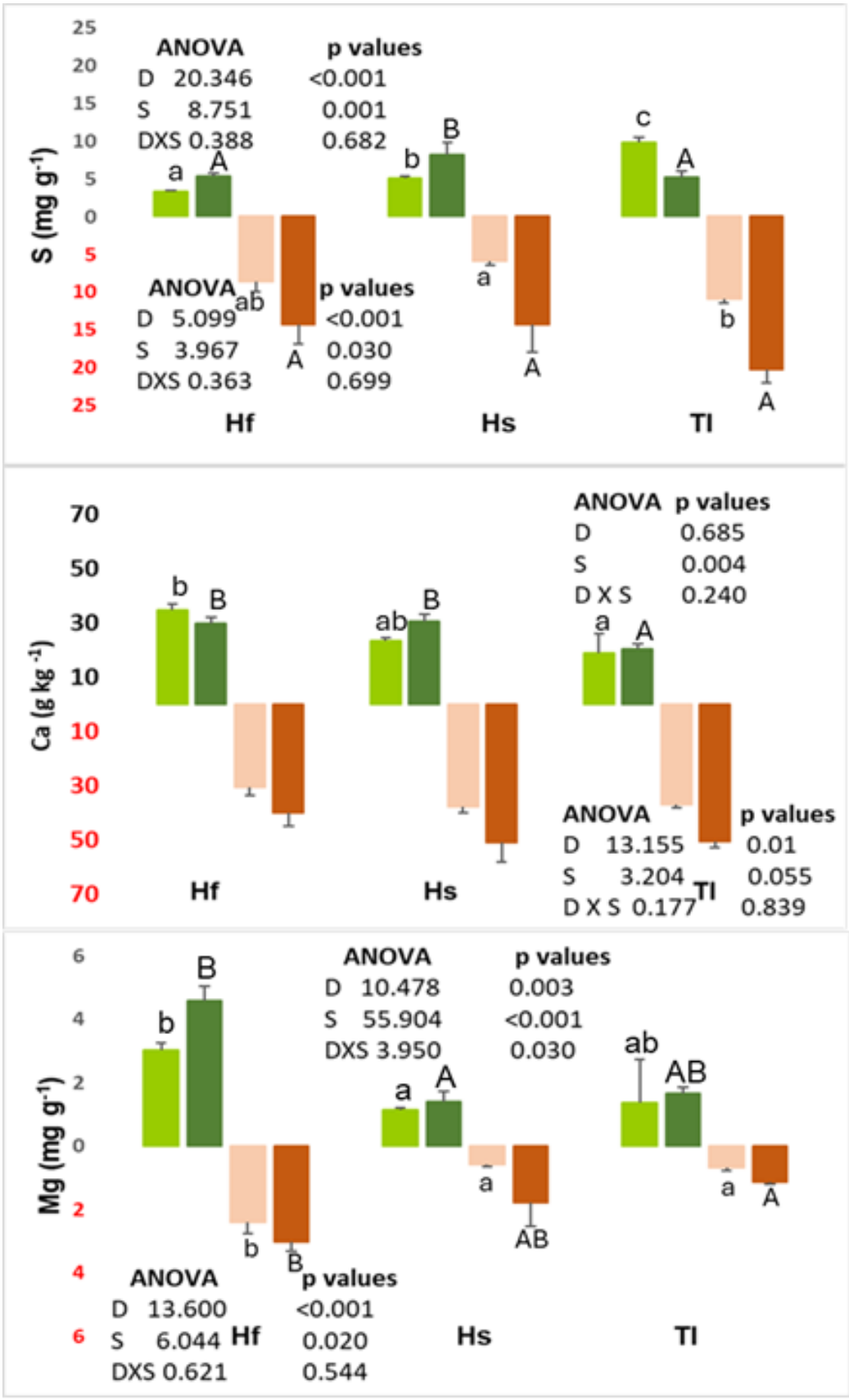
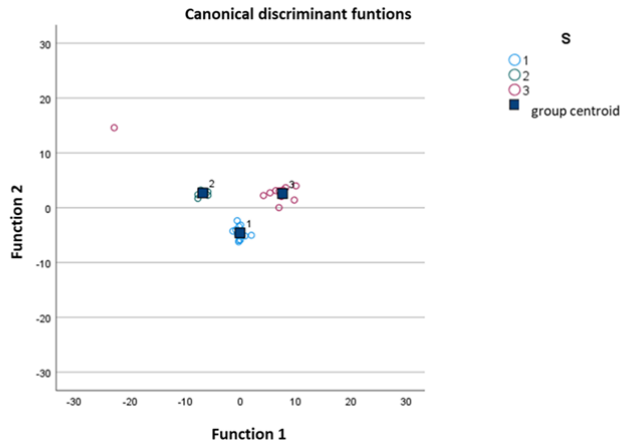
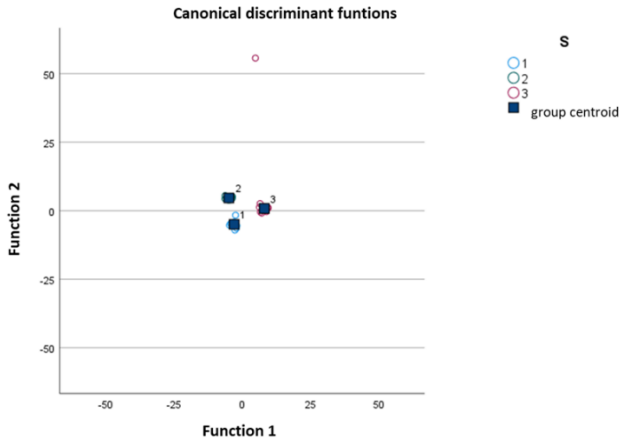

S (mg g-1)
ANOVA p values
D 20.346 <0.001
S 8.751 0.001
DXS 0.388 0.682
ANOVA p values
D 5.099 <0.001
S 3.967 0.030
DXS 0.363 0.699
Hf
Hs
Tl
Ca (g kg-1)
ANOVA p values
D 0.685
S 0.004
D X S 0.240
ANOVA p values
D 13.155 0.01
S 3.204 0.055
D X S 0.177 0.839
Hf
Hs
Tl
Mg (mg g-1)
ANOVA p values
D 10.478 0.003
S 55.904 <0.001
DXS 3.950 0.030
ANOVA p values
D 13.600 <0.001
S 6.044 0.020
DXS 0.621 0.544
Hf
Hs
Tl

Figure S3

A



B



C

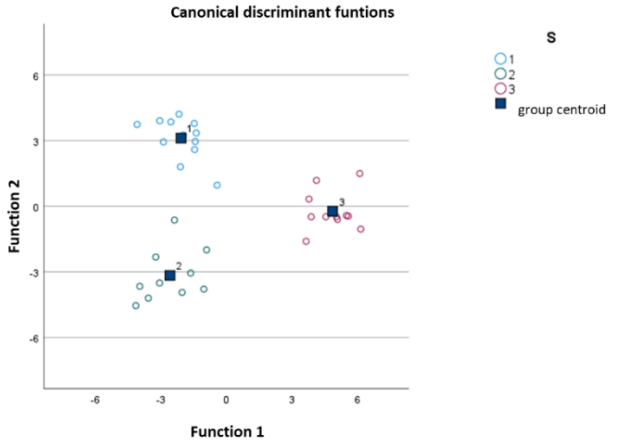


Figure S4

Figure Captions

Figure S1. Outputs of canonical discriminant functions for gypsophyte specie. Species with group centroid. S=0 non-rhizospheric soil, S=1= *Herniaria fruticosa* (Hf), S=2=*Helianthemum squamatum* (Hs), and S=3=*Teucrium libanitis* (Tl). Upper figure (**A**) with all the rhizospheric and non rhizospheric mining data. In the lower figure (**B**) only the rhizospheric soil mining data for gypsophytes.

Figure S2. Outputs of canonical discriminant functions for gypsophyte specie and cyanoprokaryota *M. chthonoplastes*. Species with group centroid. S=0 non-rhizospheric soil, S=1=*H. fruticosa* (Hf), S=2=*H. squamatum* (Hs), S=3=*T. libanitis* (Tl), S=4=*M. chthonoplastes*. Upper figure (**A**) with all soils (rhizospheric and non rhizospheric) plus *M. chthonoplastes* bioelements data. In the middle figure (**B**) only with bioelements in rhizospheric soils data, leaves of gypsophytes plus *M. chthonoplastes* data. In the lower figure (**C**) only the biolements from rhizospheric soil data, roots of gypsophytes plus *M. chthonoplastes* data.

Figure S3. S, Ca and Mg bioelements in leaves and roots or three gypsophyte for each data. Green colors indicate leaves, brown colors indicate roots, light colors are first sample data, and dark colors are data from the second sample. Hf=*H. fruticosa*, Hs=*H. squamatum* and Tl=*T. libanitis*. The Anova table located at the top or bottom of each figure indicates whether it refers to the aerial part of the gypsophyte (leaves), or the underground part of the gypsophyte (roots). Different lower letters (sampling D=1) and capital letters (sampling D=2) indicate statistically significant differences at $p < 0.05$ (Tukey´s test) between Hf, Hs and Tl.

Figure S4. Canonical discriminant functions for gypsophyte specie groups with group centroid. S=1=*H. fruticosa* (Hf), S=2=*H. squamatum* (Hs), and S=3=*T. libanitis* (Tl). Upper figure (**A**) bioelements from rizhospheric soils and leaves and roots of gypsophytes. In the middle figure (**B**) only bioelements data from leaves and roots of gypsophytes. In the lower figure (**C**) only bioelements from the leaves of gypsophytes.