Supplementary Information

Beneficial cyanosphere heterotrophs accelerate establishment of cyanobacterial biocrust

Corey Nelson and Ferran Garcia-Pichel

Supplementary Tables

Laboratory trials on sterile soil substrates					
Treatments	**Wetting events**				
	0	3	6	9	12
M. vaginatus	0.63 ± 0.17	2.59 ± 0.54	3.57 ± 0.36	3.81 ± 0.21	4.11 ± 0.31
K12	0.53 ± 0.21	2.74 ± 0.21	2.76 ± 0.37	3.16 ± 0.13	3.02 ± 0.28
O80	0.27 ± 0.18	2.98 ± 0.24	3.49 ± 0.34	6.57 ± 0.94	6.36 ± 0.69
O64	0.54 ± 0.35	2.23 ± 0.45	3.04 ± 0.62	6.51 ± 0.28	4.97 ± 1.24
METH4	0.45 ± 0.21	2.05 ± 0.34	3.56 ± 0.61	6.65 ± 1.22	6.36 ± 0.69
Mixture	0.54 ± 0.21	2.05 ± 0.34	4.62 ± 0.45	7.15 ± 0.95	11.92 ± 1.58

Table S1. Chlorophyll *a* areal concentration for laboratory trials of *M. vaginatus* grown alone and in co-culture with different heterotrophic isolates (*Escherichia coli* K12*, Arthrobacter* sp. O80, *Bacillus* sp. O64, *Massilia* sp. METH4) or as an equal proportion mixture of cyanosphere heterotrophs (Mixture) for 12 wetting events on sterile soil substrates given in mg Chl *a* m^{-2} (*n*=3; ± standard deviation). Chl *a* values for uninoculated controls were below detection for the duration of experiment and are not shown.

Outdoor trials on hot desert soil substrates					
Treatments	Wetting events				
	0	3	6	9	12
Control	0.3 ± 0.04	0.3 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.6 ± 0.4
Heterotrophs	0.3 ± 0.04	0.3 ± 0.04	0.3 ± 0.1	0.4 ± 0.1	0.3 ± 0.1
Cyanobacteria	4.7 ± 0.4	2.4 ± 0.8	5.3 ± 0.9	10.3 ± 4.9	14.3 ± 6.0
Consortium	4.3 ± 0.7	4.0 ± 1.9	20.0 ± 5.7	40.0 ± 5.9	37.4 ± 12.1
Outdoor trials on cold desert soil substrates					
Treatments	**Wetting events**				
	0	3	6	9	12
Control	6.9 ± 0.8	3.8 ± 0.3	7.4 ± 1.8	8.9 ± 1.2	10.7 ± 1.0
Heterotrophs	7.1 ± 1.1	6.8 ± 1.4	10.3 ± 2.0	18.5 ± 4.7	15.5 ± 2.9
Cyanobacteria	9.1 ± 1.5	12.9 ± 2.4	21.6 ± 6.0	15.4 ± 1.4	14.2 ± 2.3
Consortium	9.4 ± 2.0	10.3 ± 2.8	21.9 ± 2.9	22.2 ± 3.9	17.5 ± 3.2

Table S2. Chlorophyll *a* areal concentrations, given in mg Chl *a* m^{-2} (n=5; ± standard deviation), of unsterilized hot and cold desert soil substrates inoculated with beneficial heterotrophs (Heterotrophs), pioneer cyanobacteria (Cyanobacteria), or with both beneficial heterotrophs and cyanobacteria (Consortium) under field conditions for 12 wetting events.

Hot Desert				Cold Desert			
Treatment	**Cyanosphere Isolate**			**Treatment**	**Cyanosphere Isolate**		
	O64	**O80**	**METH4**		**O64**	**O80**	**METH4**
Control	-	-	-	Control	-	+++	-
Heterotroph	+++	+++	-	Heterotroph	-	+++	++
Cyanobacteria	-	-	-	Cyanobacteria	-	+++	-
Consortium	+++	+++	-	Consortium	+	+++	+

Table S3. Presence of sequences matching those of the cyanosphere heterotrophs (*Bacillus* sp. O64, *Arthrobacter* sp. O80, *Massilia* sp. METH4) in final bacterial community for outdoor trials from hot and cold desert locations (*n*=3). Crosses (+,++,+++) represent number of samples in each treatment with detected cyanosphere isolate sequences, while dashes (-) represent their absence.

Supplementary Figures

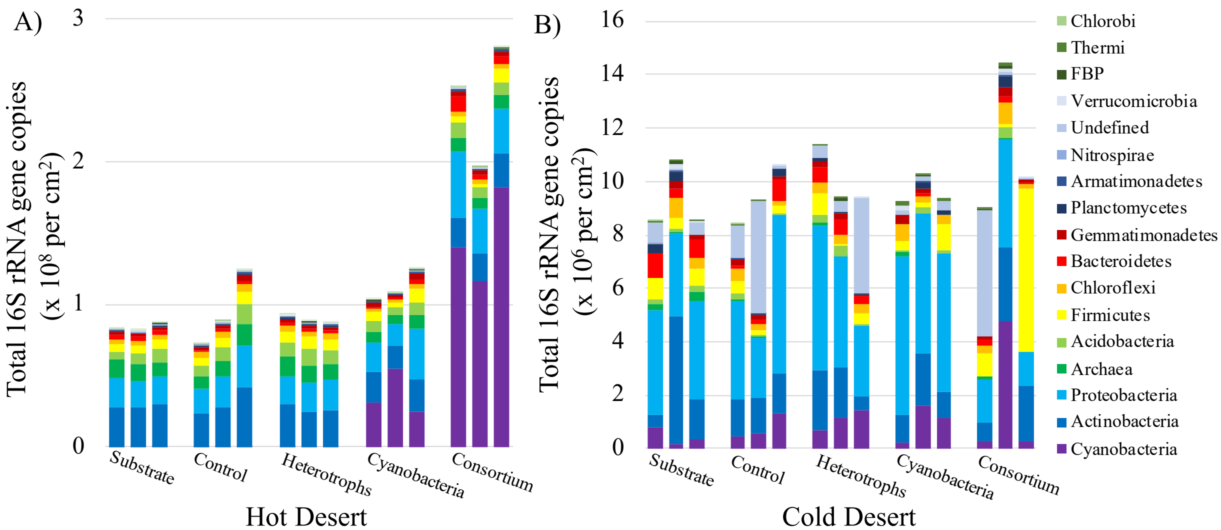

Figure S1. Bacterial abundance and community structure of original hot and cold desert soil substrates (Substrate) and of unsterilized hot and cold desert soil substrates inoculated with beneficial heterotrophs (Heterotrophs), *Microcoleus* spp. (Cyanobacteria), or with both beneficial heterotrophs and cyanobacteria (Consortium) at phylum-level as determined by high-throughput 16S rRNA gene analysis coupled to qPCR. Treatments and uninoculated control (Control) were subjected to 12 wetting events under field conditions.

Figure S2. Visual aspect of unsterilized hot desert soil substrates inoculated with beneficial heterotrophs (Heterotrophs), *Microcoleus* spp. (Cyanobacteria), or both beneficial heterotrophs and cyanobacteria (Consortium), as well as uninoculated controls (Control) after incubation for 12 wetting events. Visible formation of biocrust can be seen at the final timepoint of the Cyanobacteria and Consortium treatments.

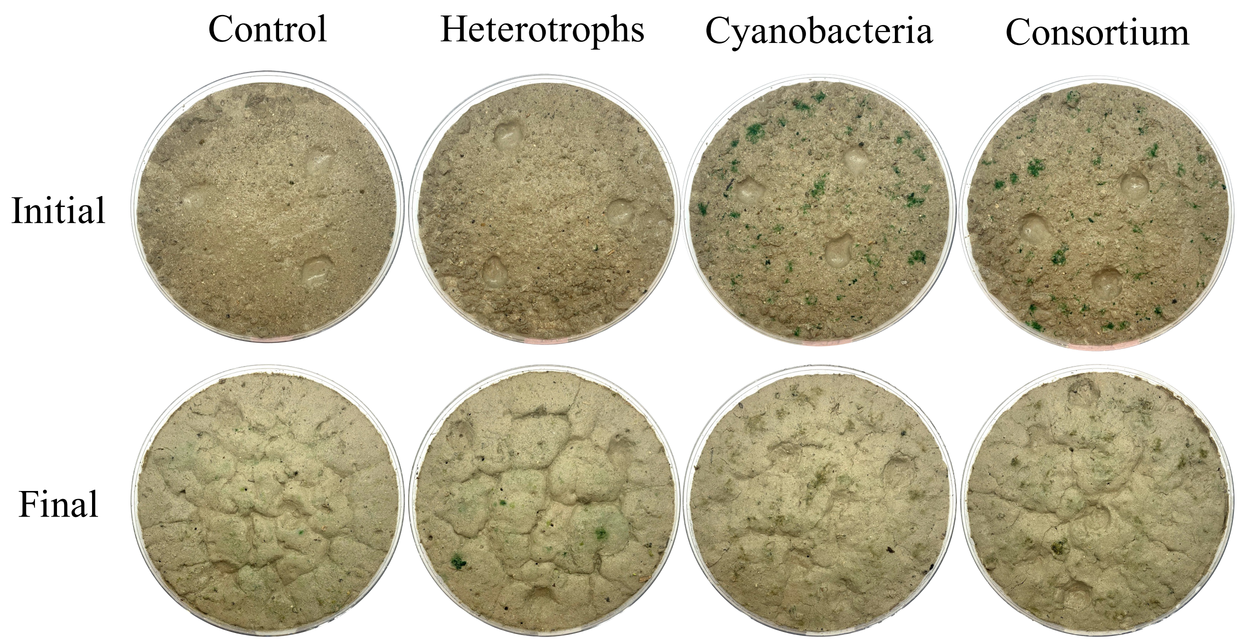

Figure S3. Visual aspect of unsterilized cold desert soil substrates inoculated with beneficial heterotrophs (Heterotrophs), *Microcoleus* spp. (Cyanobacteria), or with both beneficial heterotrophs and cyanobacteria (Consortium), as well as uninoculated controls (Control) after incubation for 12 wetting events. Visible green coloring on Cyanobacteria and Consortium treatments at initial timepoint is due to phototrophic biomass additions.