Identification of Solar-Powered N_2-Fixing Cyanobacteria from Native Ecosystems for Bio-Nitrogen Fertilizer Application in South Dakota

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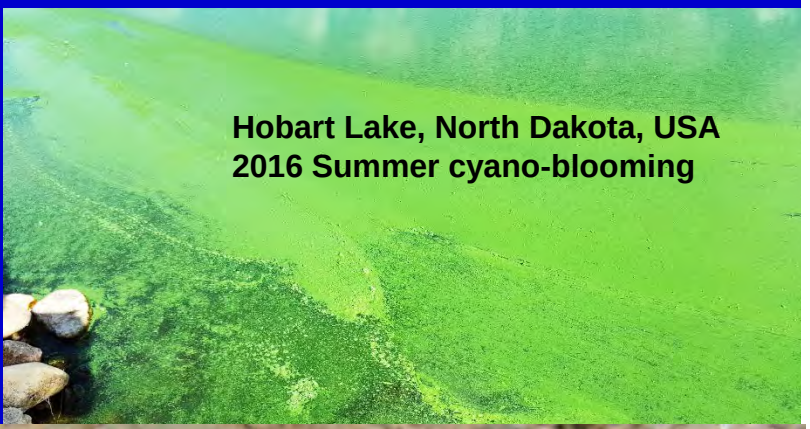
Solar-powered N_2-fixing Cyanobacteria Can Fix >10M tons of N annually to support annual biomass production by native grasses/forests

Unique Solar-powered, N_2 & CO_2-Fixing Biochem Pathways

Cyanobacteria can fix ≈ 50% of 258 billons tons of CO_2 annually, also fix >10M tons of N annually

(258,000,000,000 tons CO_2 on earth are fixed biologically annually)

All life forms on Earth are relying on these Two Most Fundamental Biochem Pathways



Sunlight and N_2 gas are the most abundant resource around us

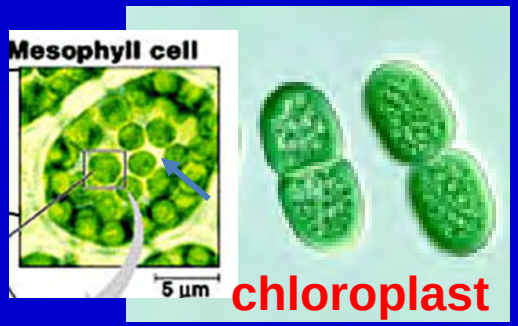
Dinitrogen (N_2 gas) as a resource is 2,000-fold more abundant (78%) than CO_2 (0.04%) in the atmosphere and can be converted into numerous of high-demand chemicals by N_2-fixing cyanobacteria.

Although we are surrounded by this vital resource such as N2 gas and solar energy, but we cannot easily use it since they are in the wrong form.

Fortunately, the uniquely, solar-powered N_2-fixing cyanobacteria can help us to use these two unlimited natural resources.

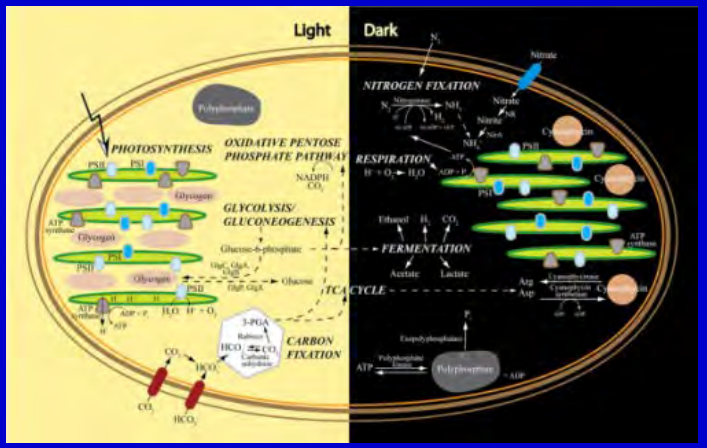
How Can They Do So?

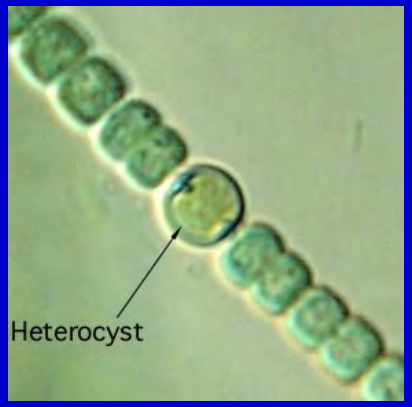
Two Major Groups of Solar-Powered N_2-fixing Cyanobacteria



Temporarily

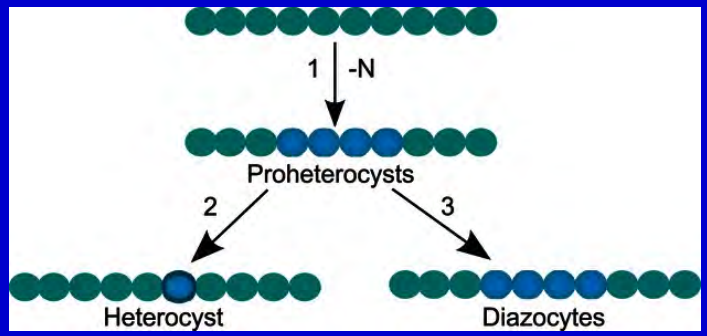
By timing and circadian rhythm





Spatially

Specially differentiated cells



Project Objectives

- Isolation of N_2-fixing cyanos from native ecosystems in SD (Y1-Y2)
- Quantifying their capability of nitrogen fixation (Y3-Y4).
- Inoculate the best isolates with plants in a sterilized agar-plate and Qatar sands to test its impact on plant growth (Y4).
- Then move to a sterilized soil and actual soil in greenhouse trials (Y5)
- Finally field trials (Y6).
- Commercial production of solar-powered nitrogen-fixing cyanos for bio-N fertilizer (Y7-Y10).

Identify N_2-Fixing Cyanobacteria in Topsoil of SD

The Best Organisms Under the Sun

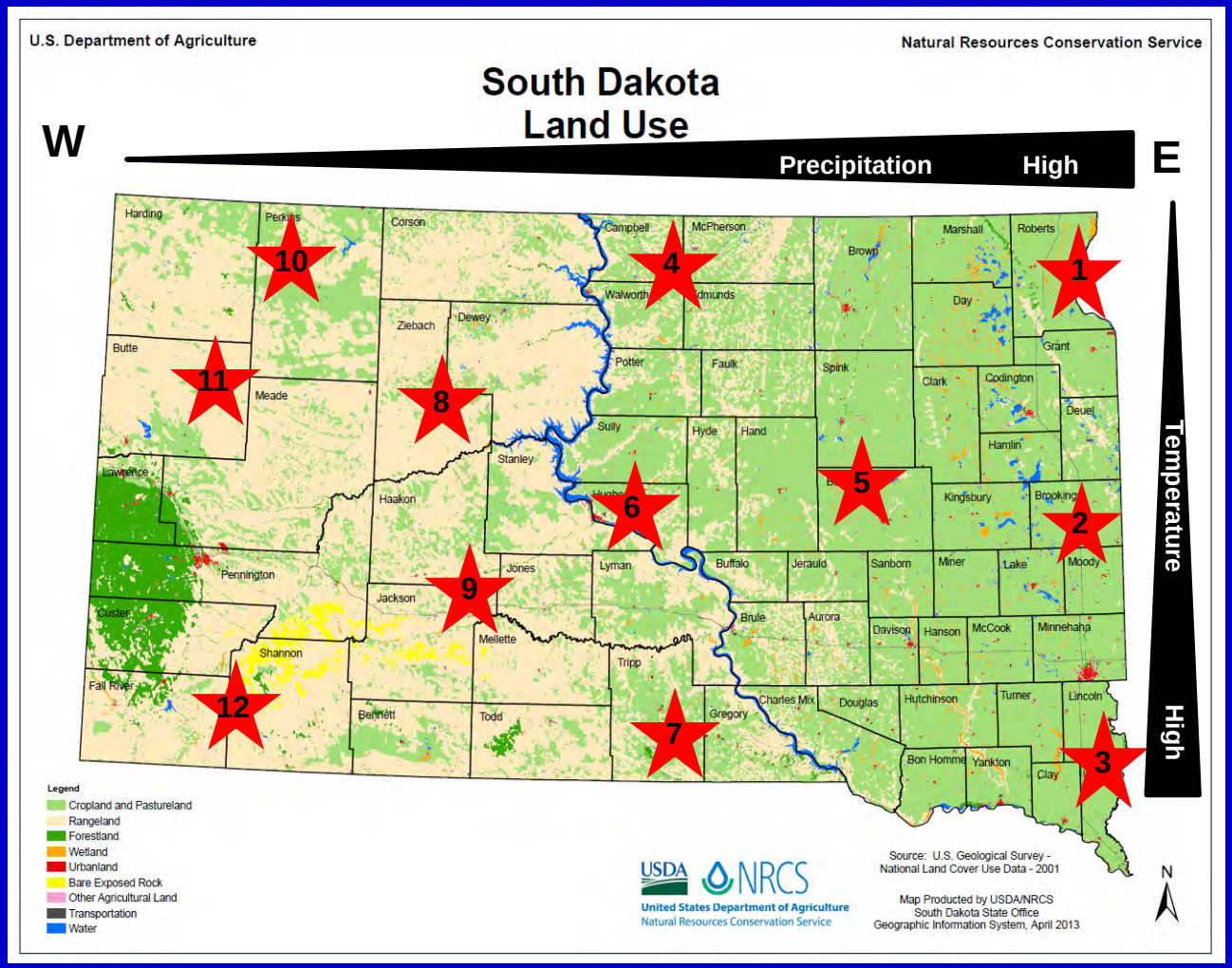


Fig. 2. Distribution of topsoil sampling sites at SD


Xu Lan's soil samples
T5
M1#
M2.*
M3*
M4#
M5#
M6#
M7#
M8#
M9#
M10#
M11#
M12#
M13#
M14#
M15#
M16#

>1000 agar-plates were used to screen for N2-fixing cyanobacteria

Results Summary

1) From the **244** topsoil samples, **we have isolated at least 15 new potential N_2-fixing cyanobacterial strains** that are able to reproducibly grow well on $BG11_0$ agar plates (without any fixed nitrogen), suggesting that these **15** strains can fix nitrogen using solar energy.

1) Interestingly, we noticed that 15 potential N_2-fixing cyanobacteria seems exclusively found in **either No-till crop soils or native ecosystem**, Not in tilled crop soils.

2) Microscopy verified that eight of them are filamentous cyanobacteria, and seven of them are unicellular cyanobacteria/microalgae.

3) Acetylene reduction assay confirmed at least **5 strains** (all filamentous) have great nitrogenase activity.

4) The other 10 potential N_2-fixing cyanobacteria or microalgae strains are currently under purification to test for nitrogenase activity

BLN-C1 B, N-

Grown as biofilm


018-05-21 12:31 PM
at: 43° 46' 33.4272" N
on: 102° 0' 1.9284" W
ng467
BLN-C1B was isolated from this mega-drought condition
ST-02
2018-05-21

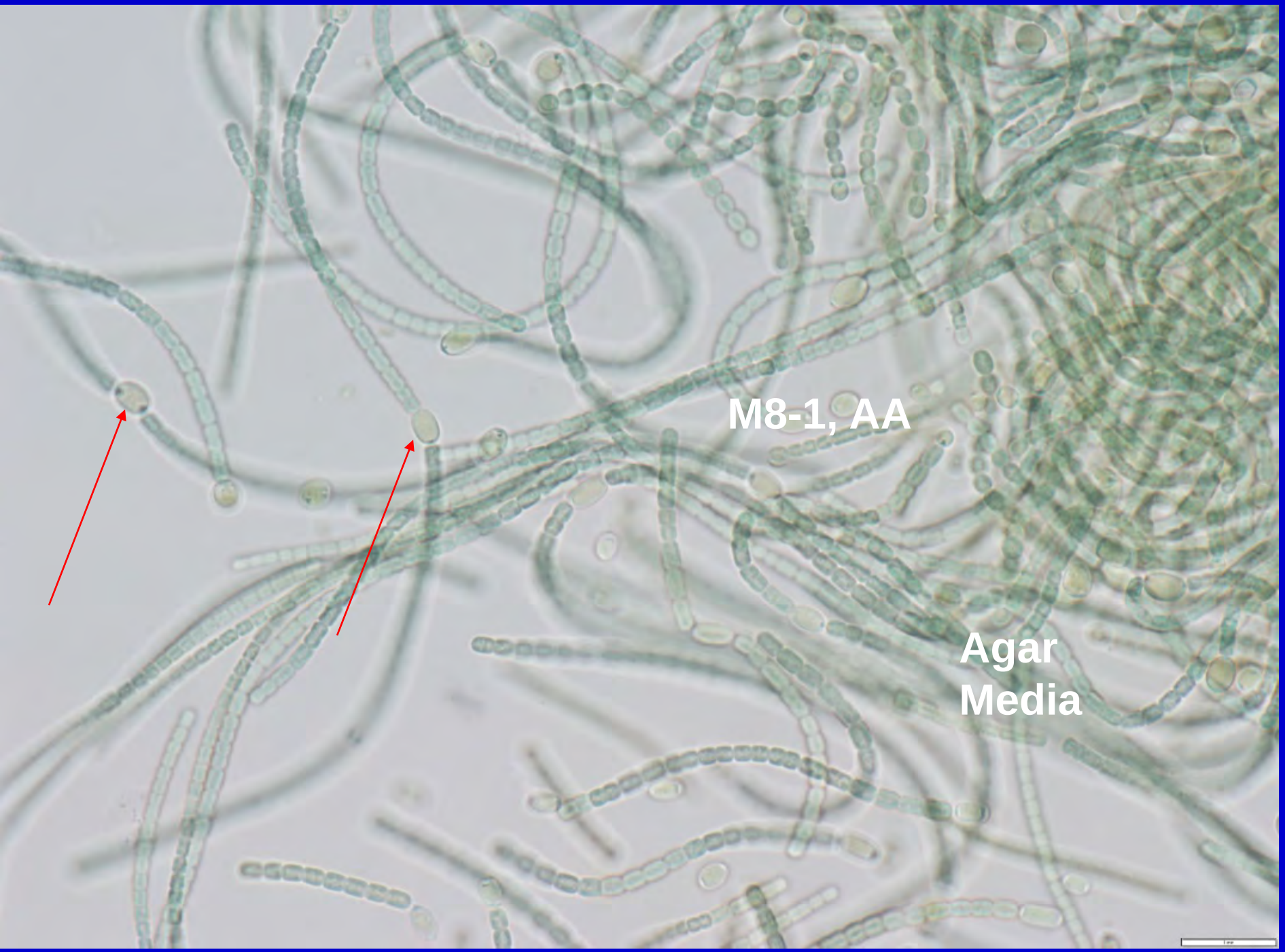
M4-Bg110 liquid

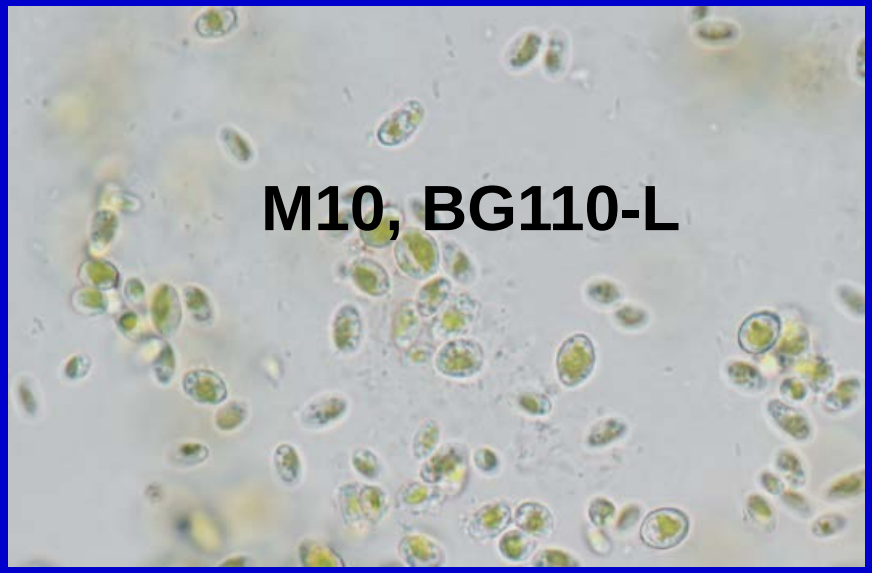
M4-BG110 plate

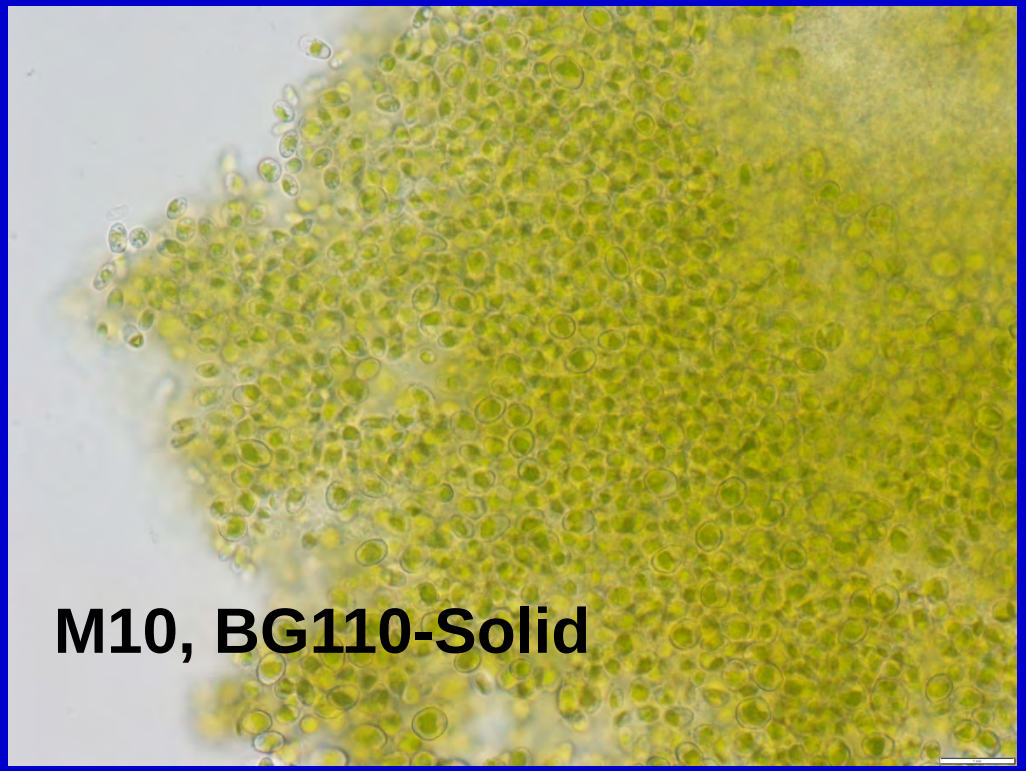
Without fixed nitrogen

With fixed nitrogen

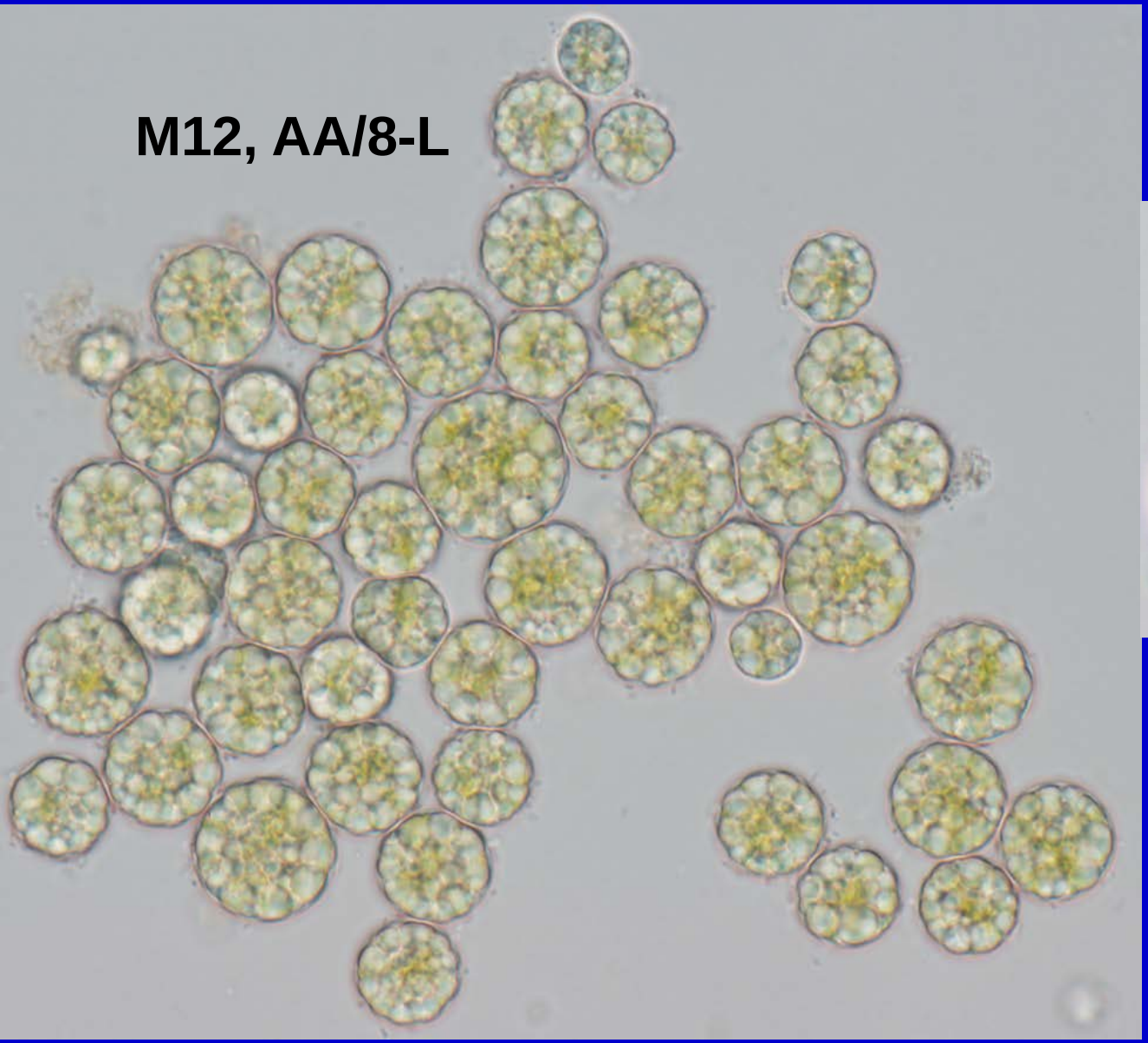
SDH-2B.1 N- 40x


M8-1, AA
Agar
Media

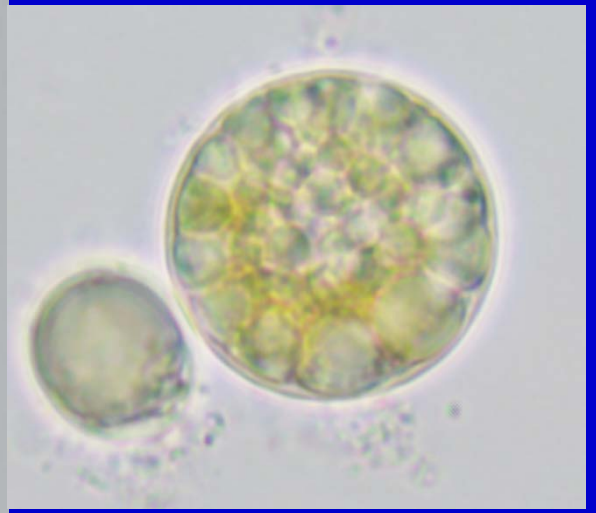

M10, BG110-L


M10, BG110-Solid

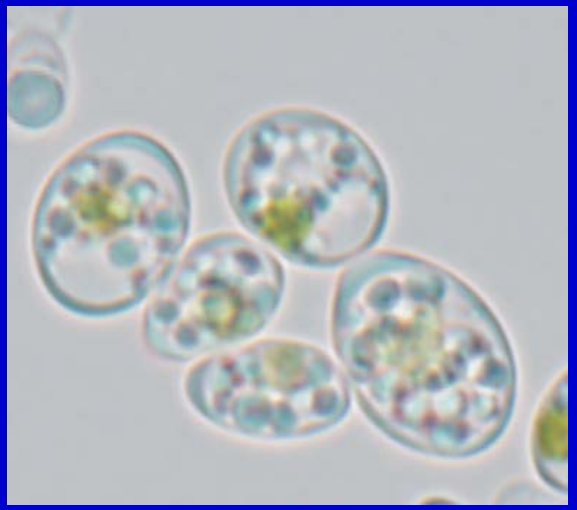
M12, AA/8-L

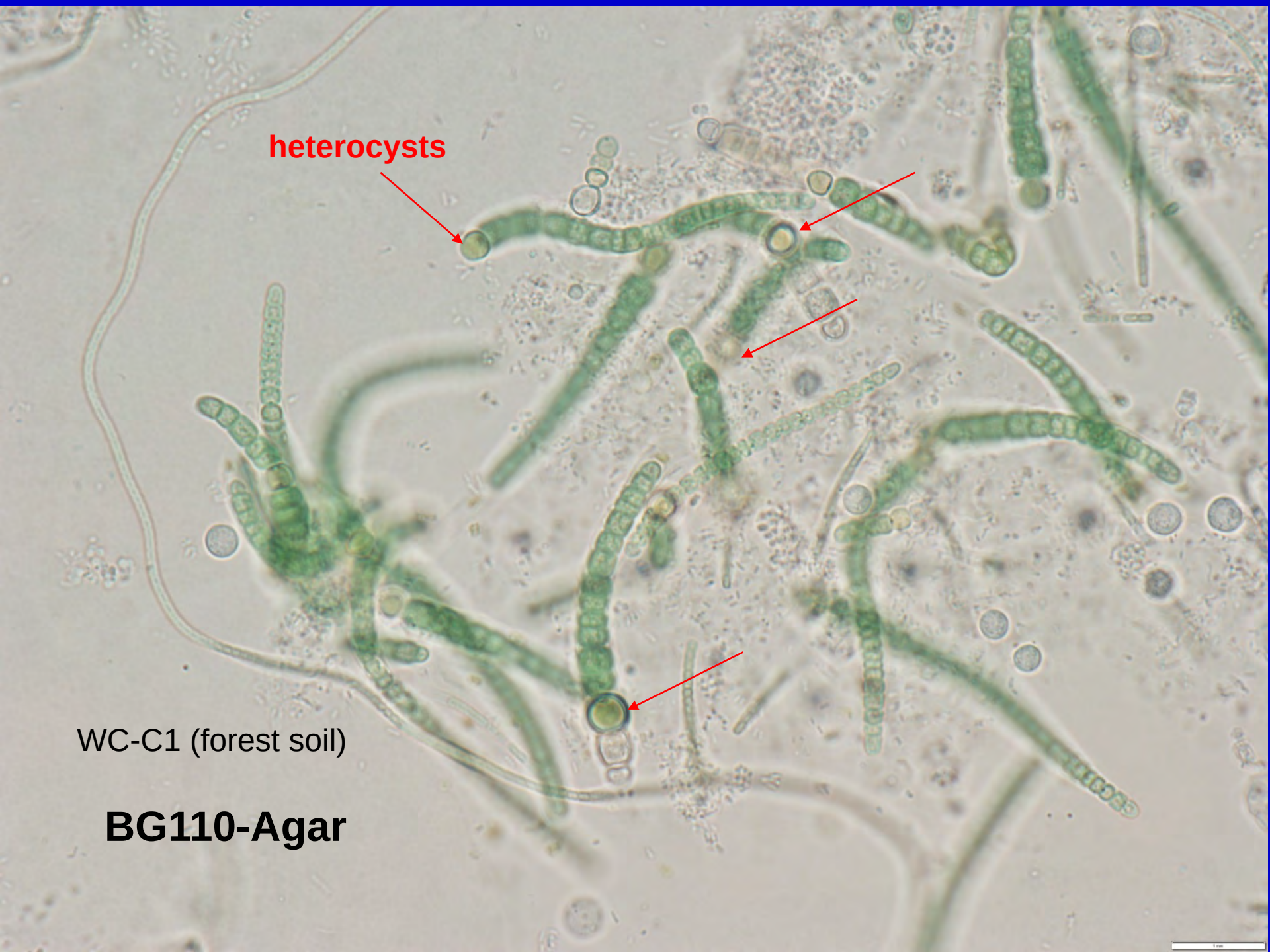


M12, AA



Xu81, native grasslands, AA solid




heterocysts
WC-C1 (forest soil)
BG110-Agar


CSP-C2,
BG110-Agr

Thank you so much for funding this pioneer research!

We wholeheartedly plead your continued supports on my next proposal!