
Microcoleus lacustris (*Limnofasciculus* sp. nov.)

College of Science
DEPARTMENT OF ENVIRONMENTAL SCIENCE AND POLICY
George Mason University
ICPRB
potomacriver.org

Overview of Benthic Algal Communities, Including Harmful Cyanobacteria, in Shenandoah River, Virginia

Christova, R. S., Van Aken, B., Jones, R. C, Selckmann, G. M.

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College of Science
POTOMAC ENVIRONMENTAL RESEARCH AND EDUCATION CENTER
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Thank you!

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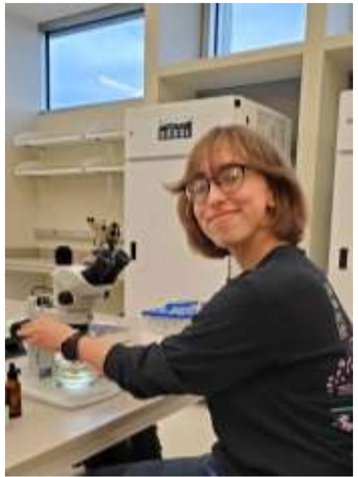
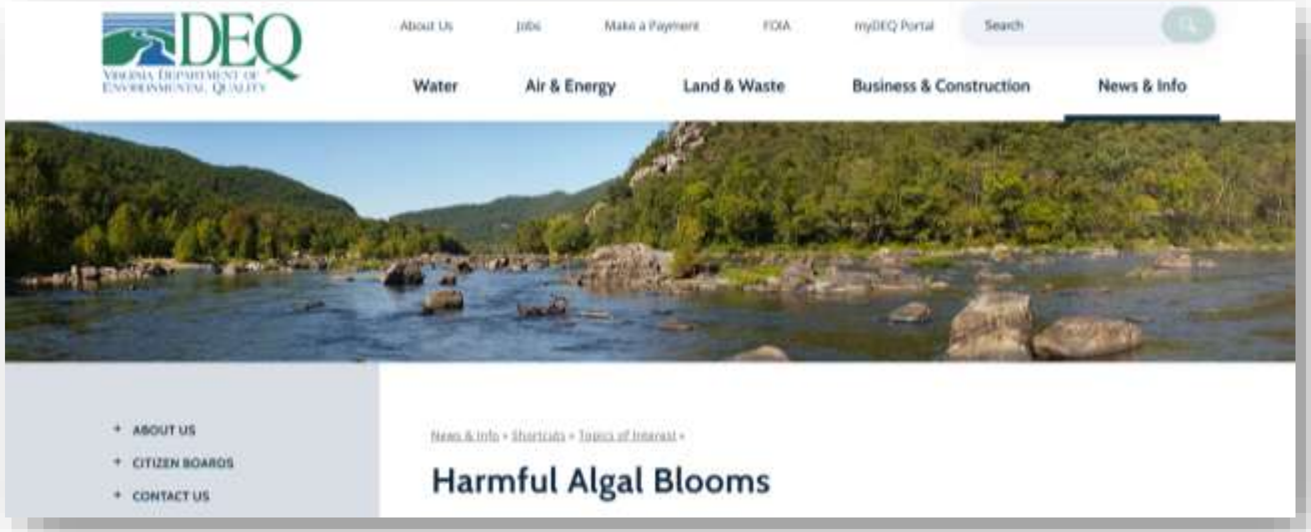
ICPRB: G. M. Selckmann, C. O'Brian
GMU: L. Underwood, R. C. Jones, S. M. Brown, J. Mormando, K. Holguin, H. Toney, L. Birsa, B. Van Aken, S. P. Jaskiewicz, P. M. Gillevet, M. Sikaroodi, J. Salerno
UVA Wise: A. B. Cahoon

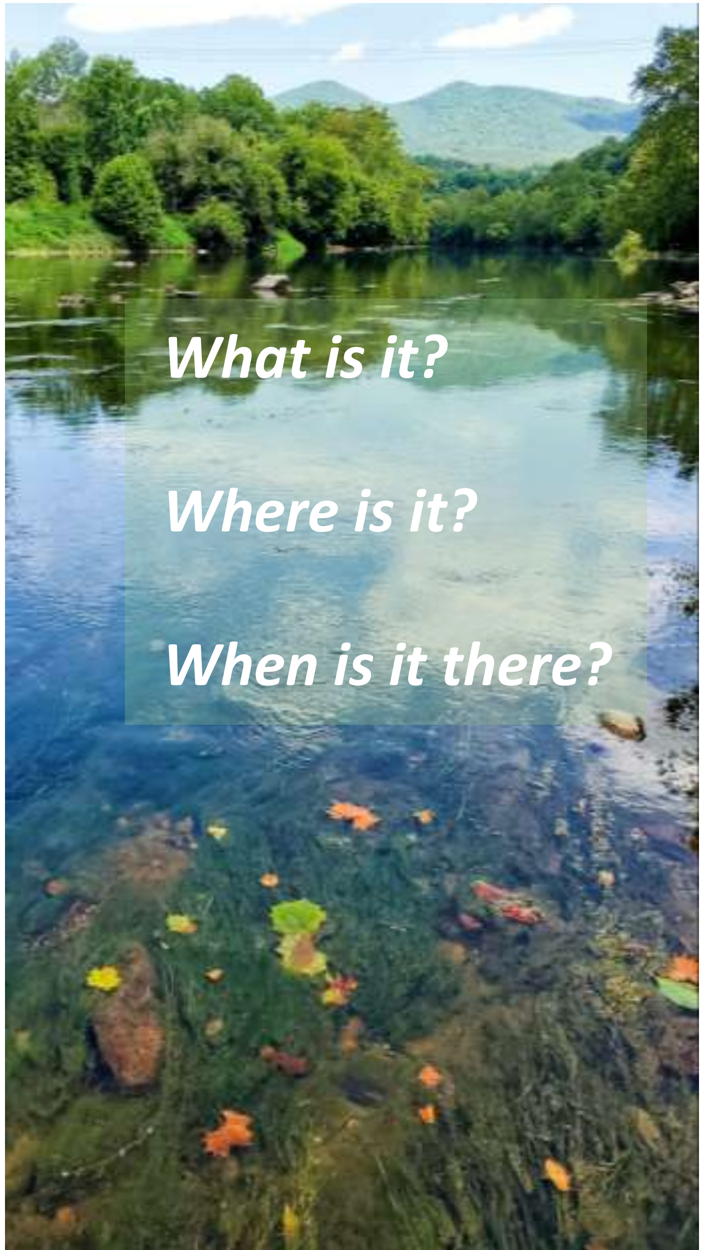


Objectives: Shenandoah River HABs

- In July and August 2021, DEQ investigated multiple reports of potential HABs along the North Fork Shenandoah River. Subsequent laboratory analysis indicated that algal toxins were present within algal mats in multiple locations.
- Recreational advisory covered approximately 52.5 miles of the North Fork Shenandoah River.



https://www.deq.virginia.gov/topics-of-interest/harmful-algal-blooms



Sampling Approach

North Fork: 6 stations (NF 5, 6, 7, 8, 10, 11)

South Fork: 4 stations (SF 1, 2, 3, 4)

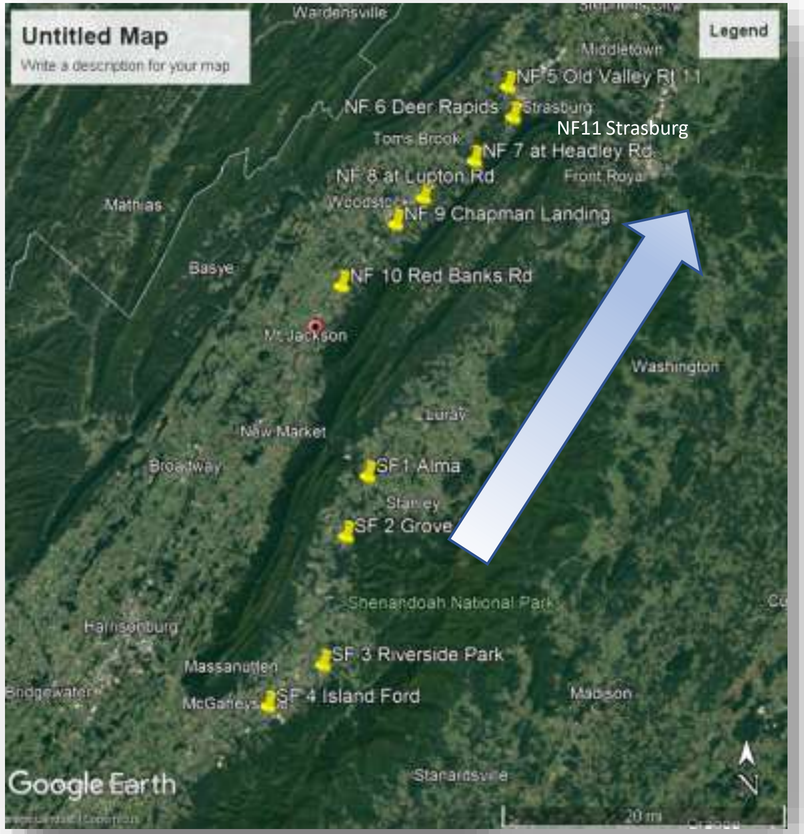
2023: July – October (27 Quant, 33 Qual)

2024: June – October (52 Quant, 57 Qual)

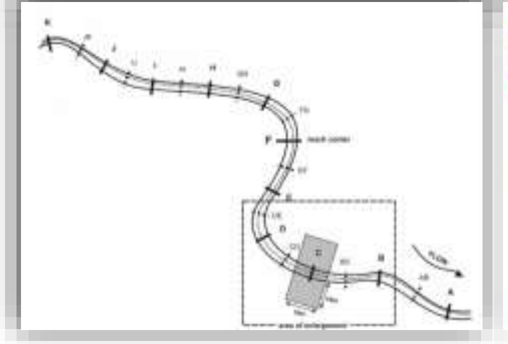
2024: Longitudinal samples (24 Quant)

- The quantitative multihabitat composite algal sample was collected from known area sampled at 9 main transects along 150 m long stream reach.
- Fresh qualitative mat samples were also collected.

Quantitative preserved sample



Fresh qualitative sample DNA extractions



Reach length = 150 m for streams ≤ 10 m average wetted width
= 250 m for streams > 10 m average wetted width

Algal Taxonomic and Toxin Analyses

- ***Subsample for quantitative algae analysis:*** macroalgal fraction volume measured by water displacement (mL)
- All macroalgae, including large colonial diatoms, identified to morphospecies and biovolume reported as mm^3/cm^2 area sampled; Algal epiphytes identified and listed

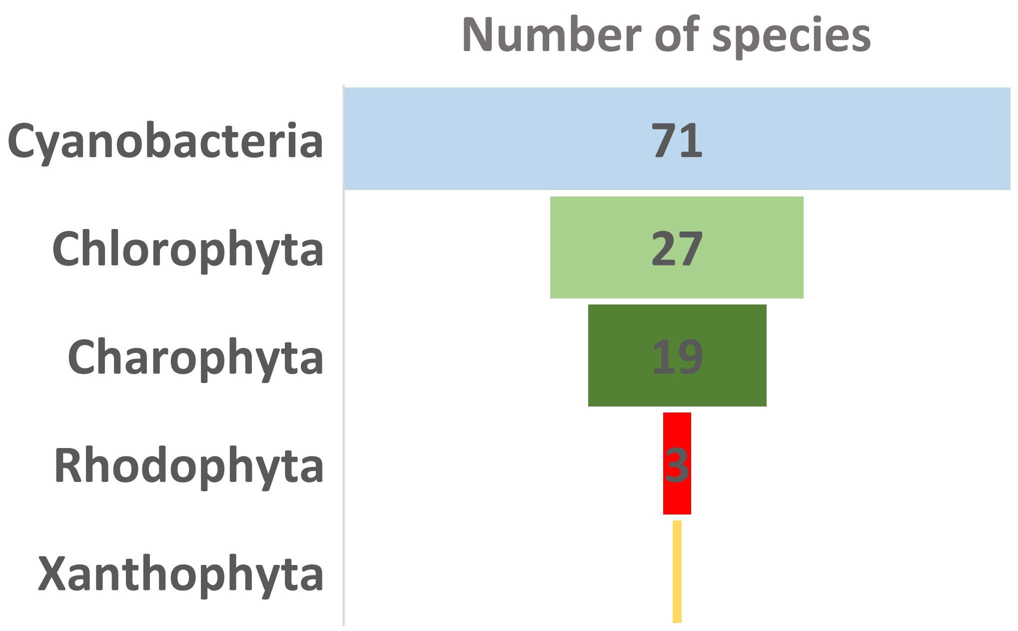
- ***Subsample for toxins:*** Cyanotoxins measured by LCMS/MS and ELISA (Dr. Van Aken)

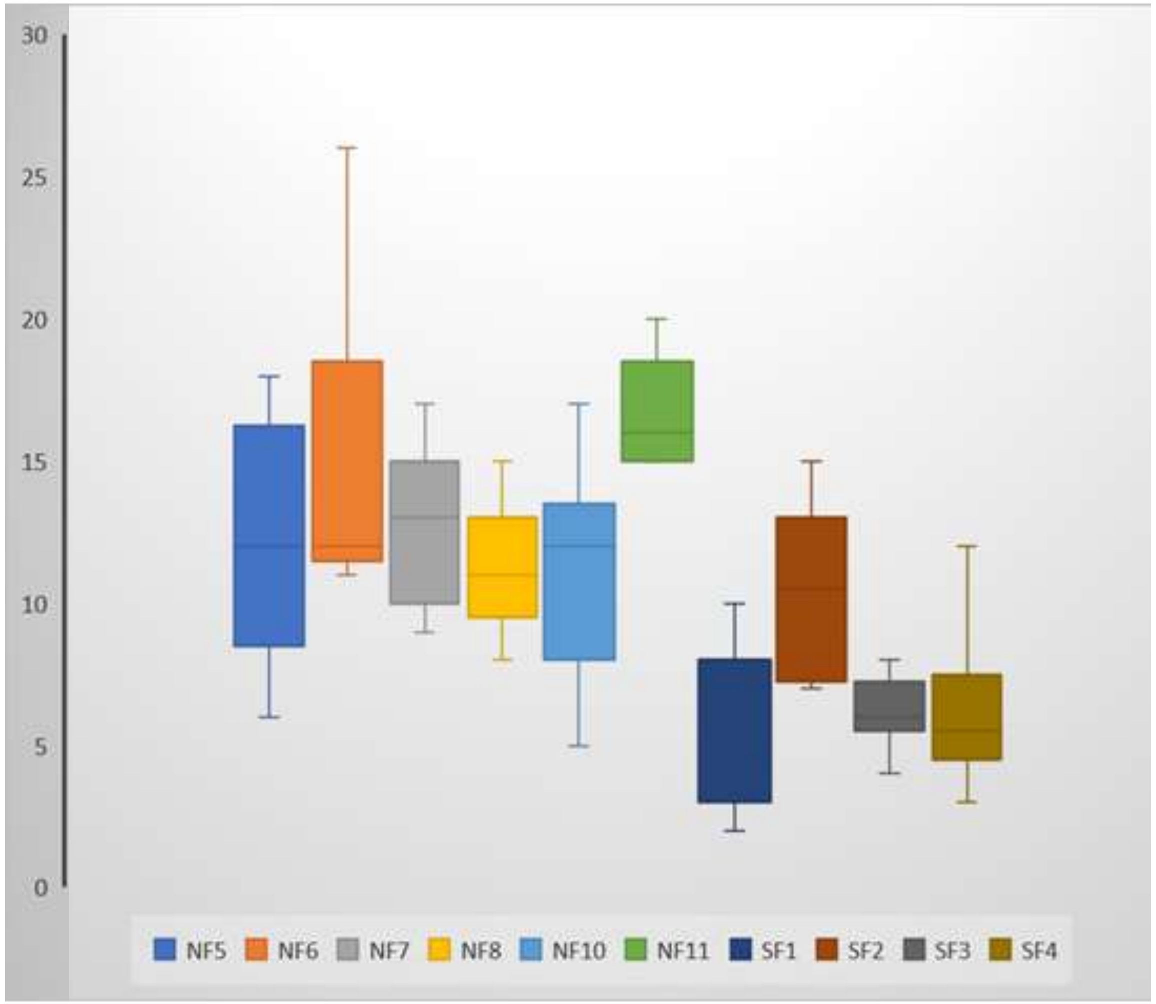
Anatoxin-a (ATX)
Dihydroanatoxin-a (dhATX)
Homoanatoxin-a
Saxitoxins (SAX)
Microcystin-LR
Microcystin-RR
Cylindrospermopsis
Nodularin

NF8 (Lupton, 8.22.23) Macroalgal fraction volume 3.9 mL

Results

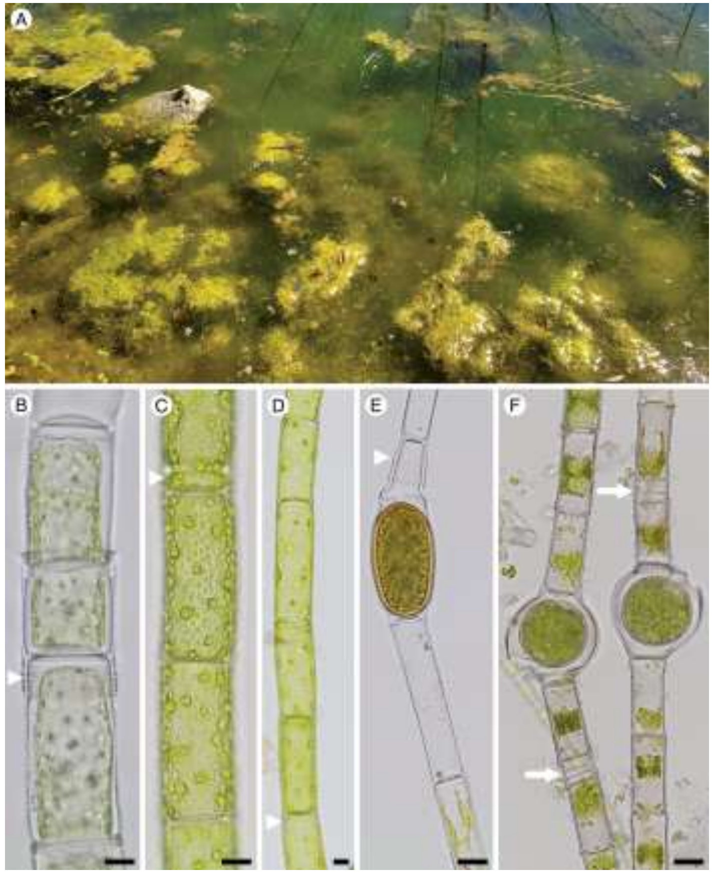
- **We recorded 121 algal morphospecies** (excl. epiphytes) belonging to five algal phyla
- Data for **79 quantitative multihabitat samples** are presented
- **Median species richness per sample was 11 morphospecies** (range from 2 to 26 species)



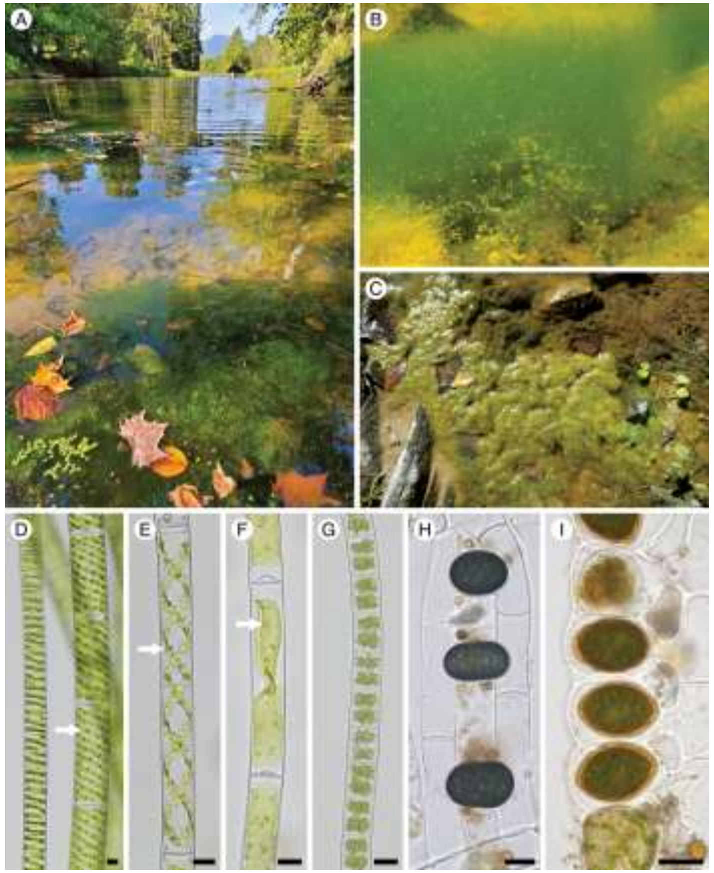


Results

- Most diverse cyanobacterial genera were *Geitlerinema* (8 sp.), *Oscillatoria, Microcoleus* and *Phormidium* (6 sp.), *Schizothrix, Leptolyngbya, Calothrix* (4 sp.)
- The most diverse green/charophyte algae were *Oedogonium* (10 sp.) and *Spirogyra* (9 sp.), which were recorded in 40% of the samples, sometimes in high abundance

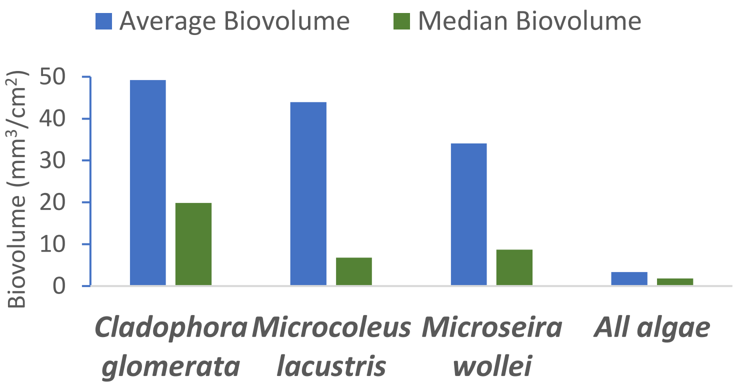


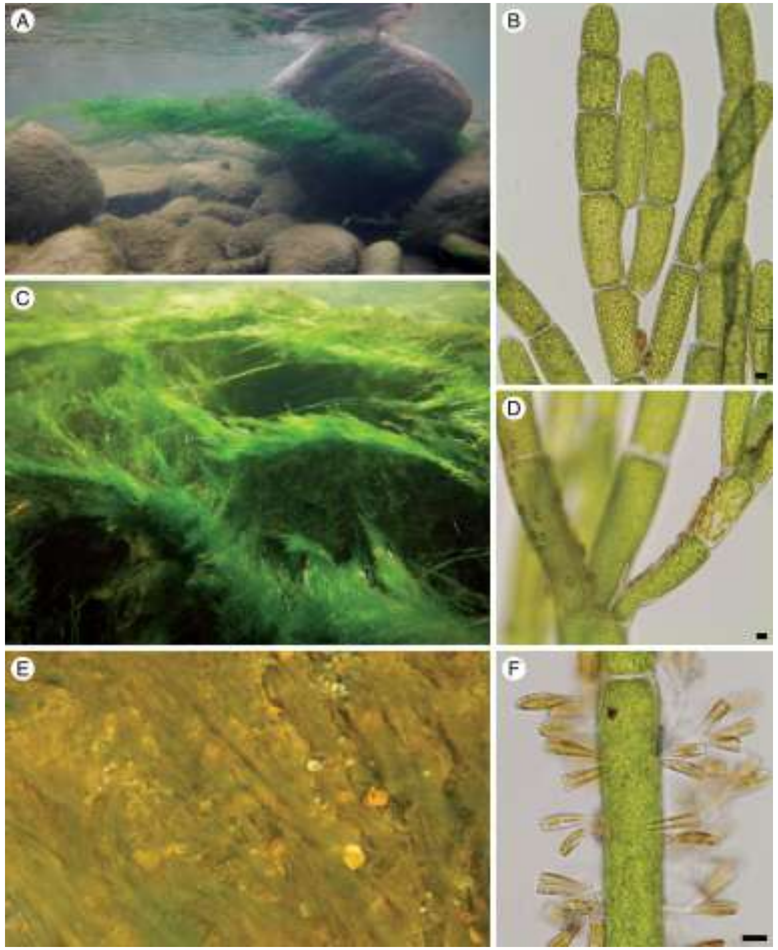
Oedogonium (green algae)



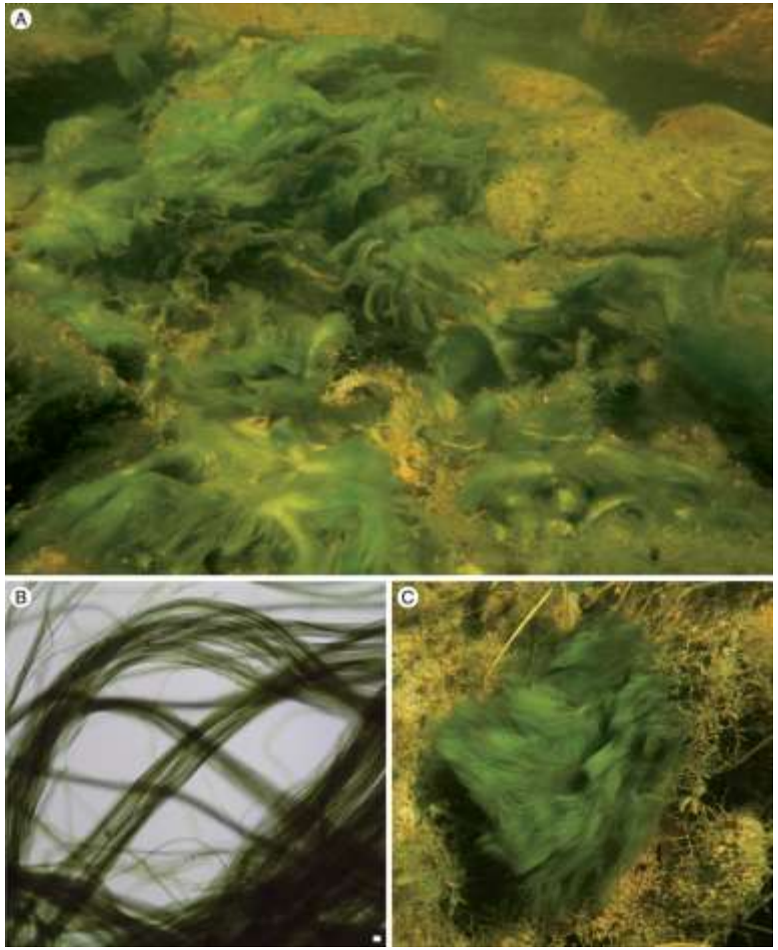
Zygnematophyceae (charophyte algae)

Top Three Most Common and Abundant Species

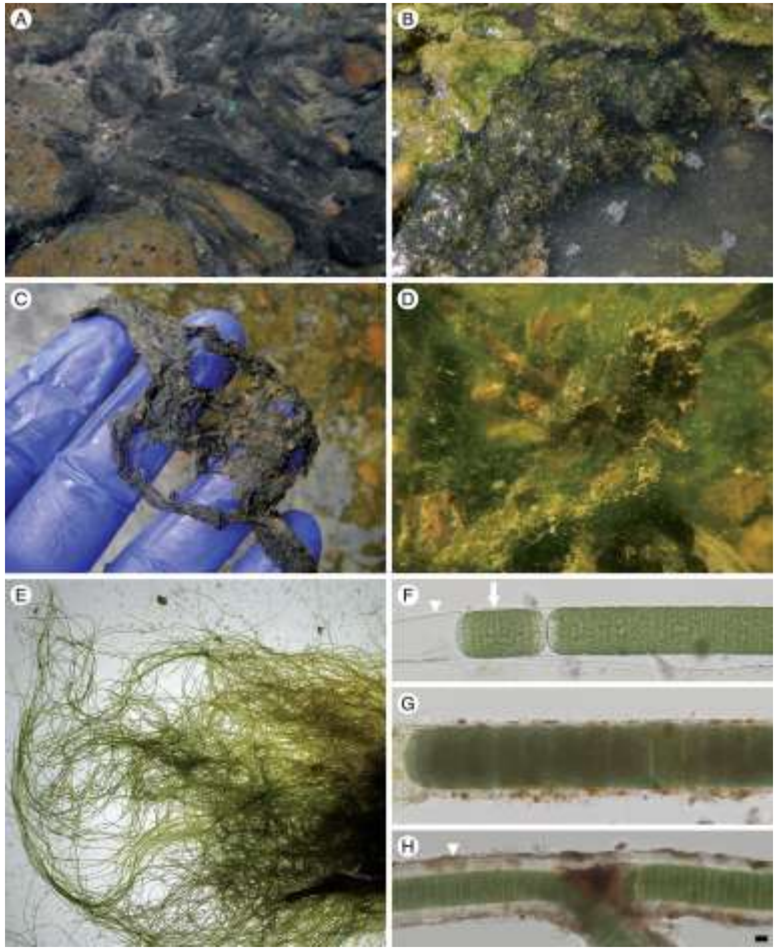




Cladophora glomerata



Microcoleus lacustris



Microseira wollei

Cladophora glomerata

- Recorded in 97% of the samples in all sites
- Peak biomass in NF5 (7.26.23) – 362 mm^3/cm^2
- Non-toxic

Microcoleus lacustris (*Limnofasciculus* sp. nov.)

- Recorded in 48% of the samples in all sites
- Peak biomass in SF5 (8.9.23) - 694 mm^3/cm^2
- Toxicity unknown

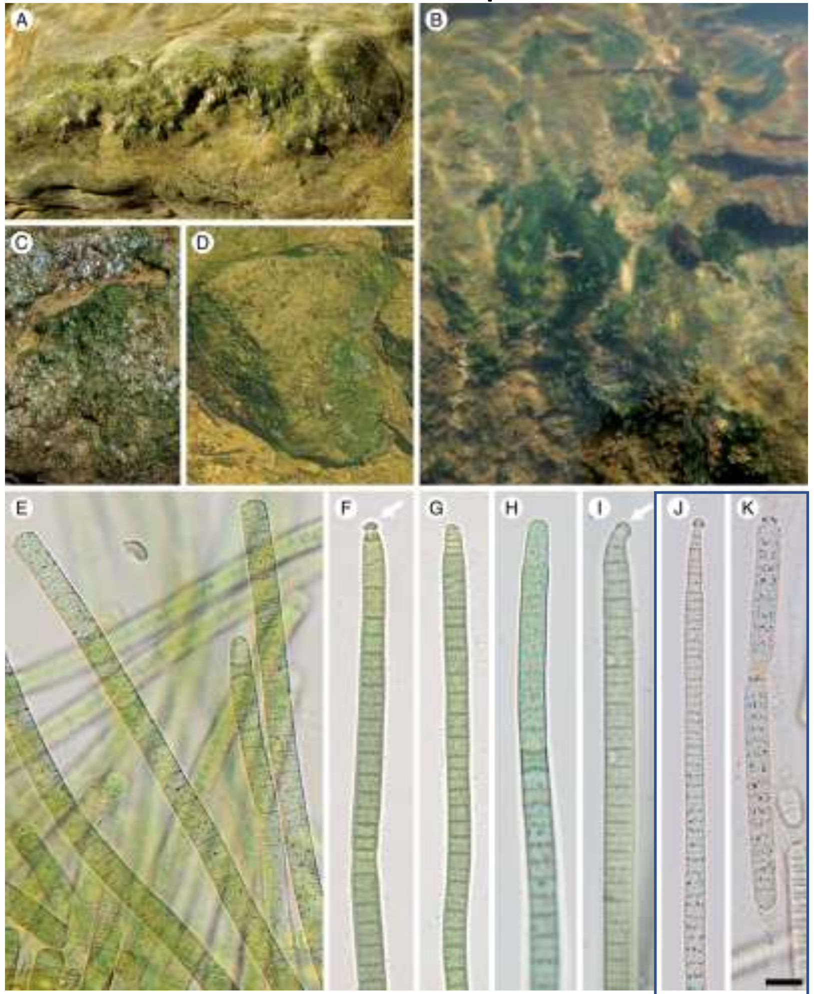
Microseira wollei

- Recorded in 53% of the samples, missing in NF10, SF1, SF3, SF4
- Peak biomass in NF5 (9.23.23) - 285 mm^3/cm^2
- Saxitoxins, lyngbyatoxins, cylindrospermopsin

Anatoxin-Producing Cyanobacteria

- *Microcoleus* spp.

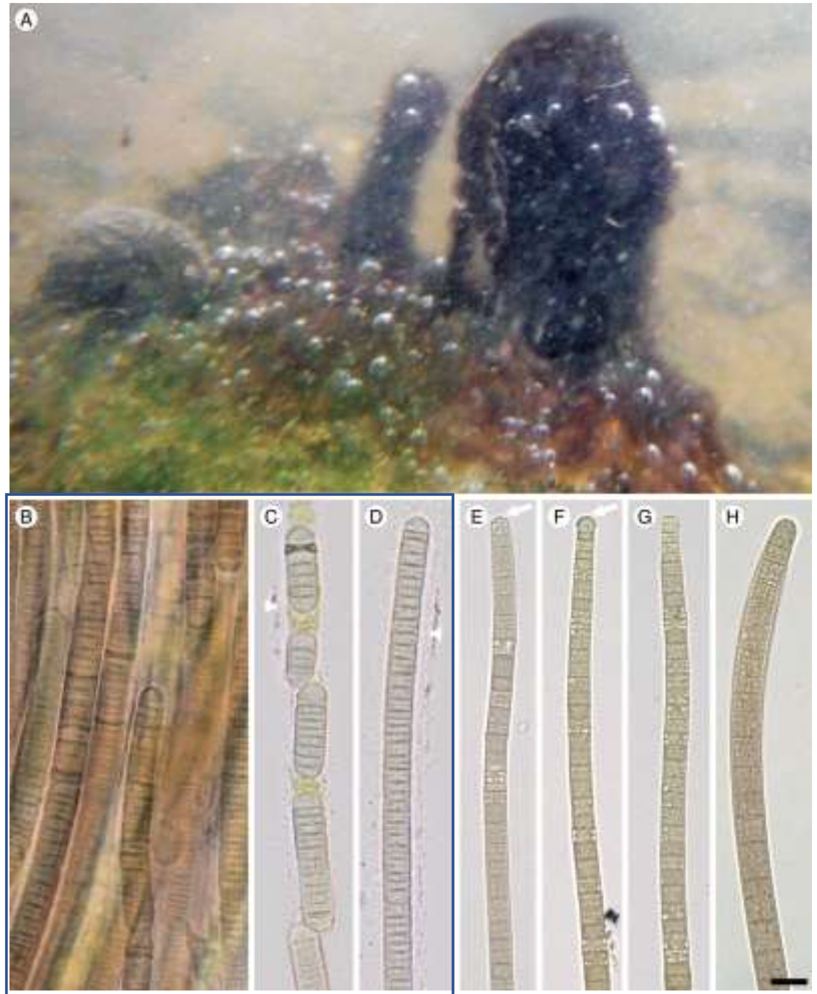
In 62% of the samples



Monoclonal cultures: (SF1)

- *Microcoleus* cf. *anatoxicus* (ATX+dhATX)

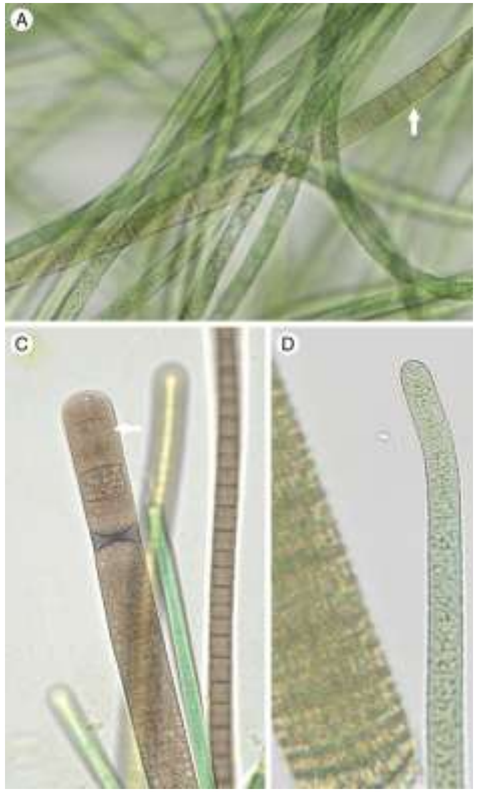
Recorded in SF2, 4, NF5, 6, 7, 8, 11

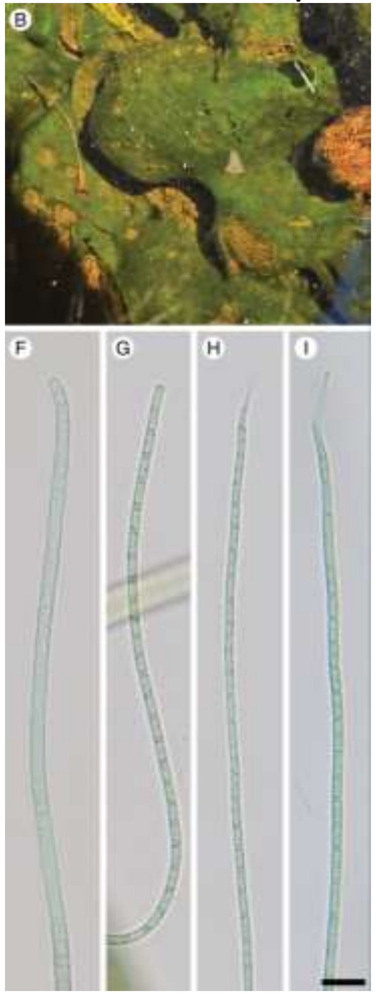


(NF10)

- *Geitlerinema*
- *Anagnostidinema*

In 26% of the samples

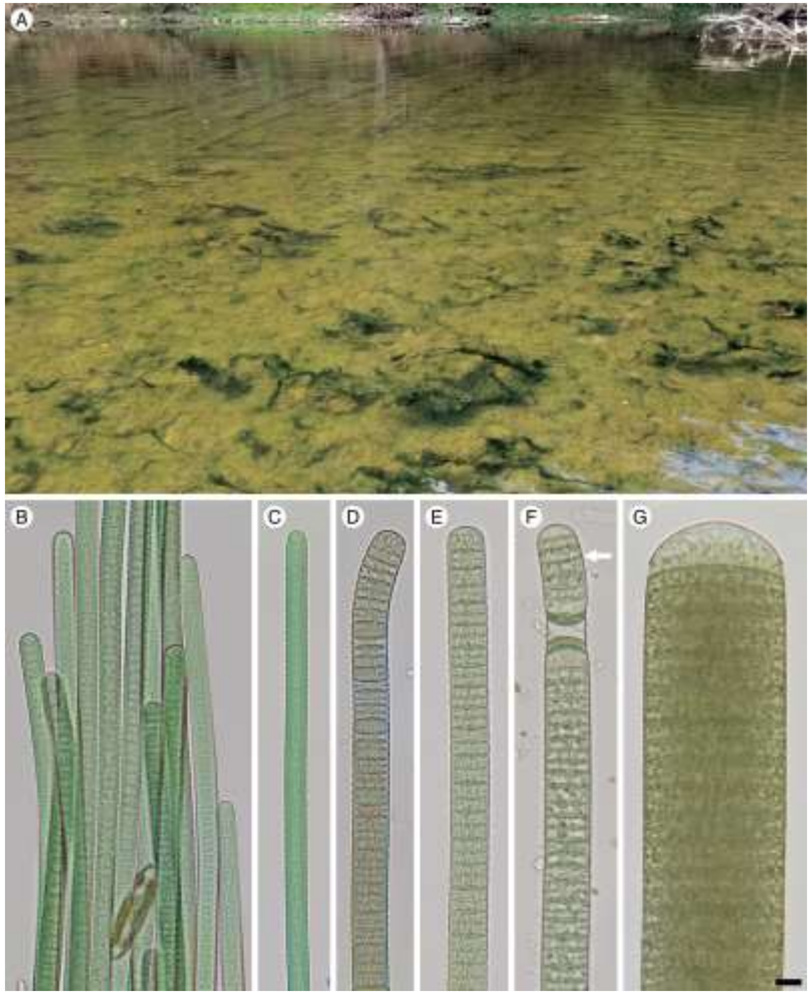


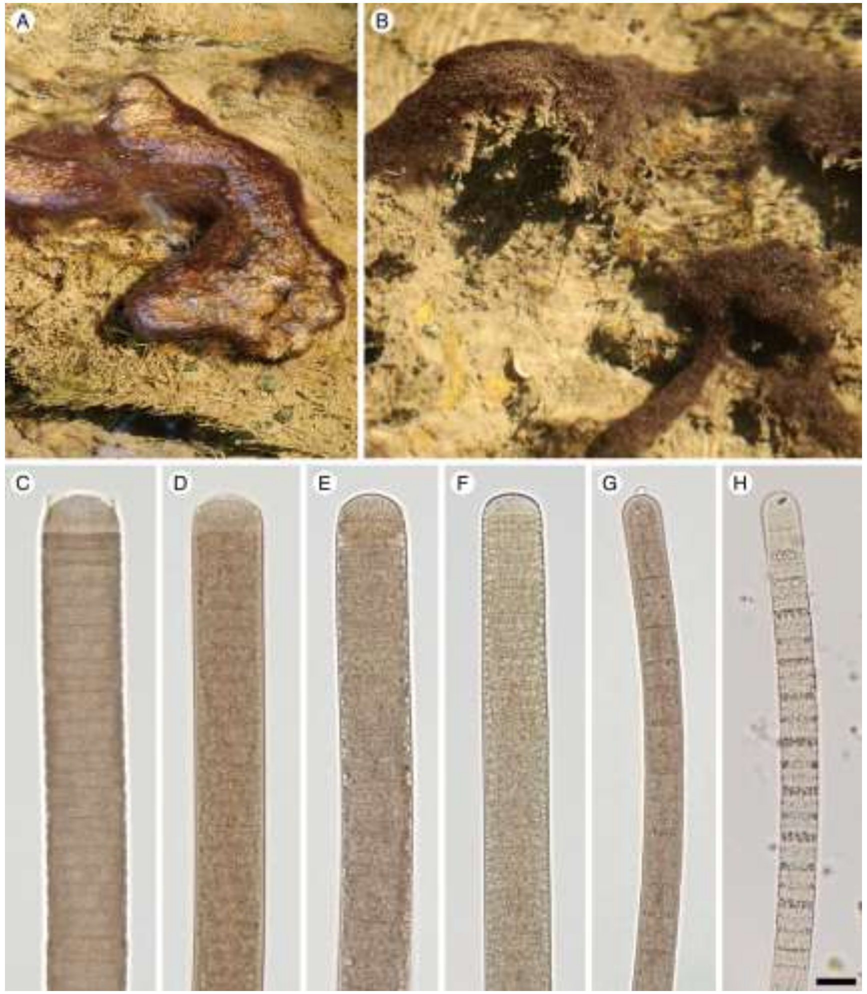


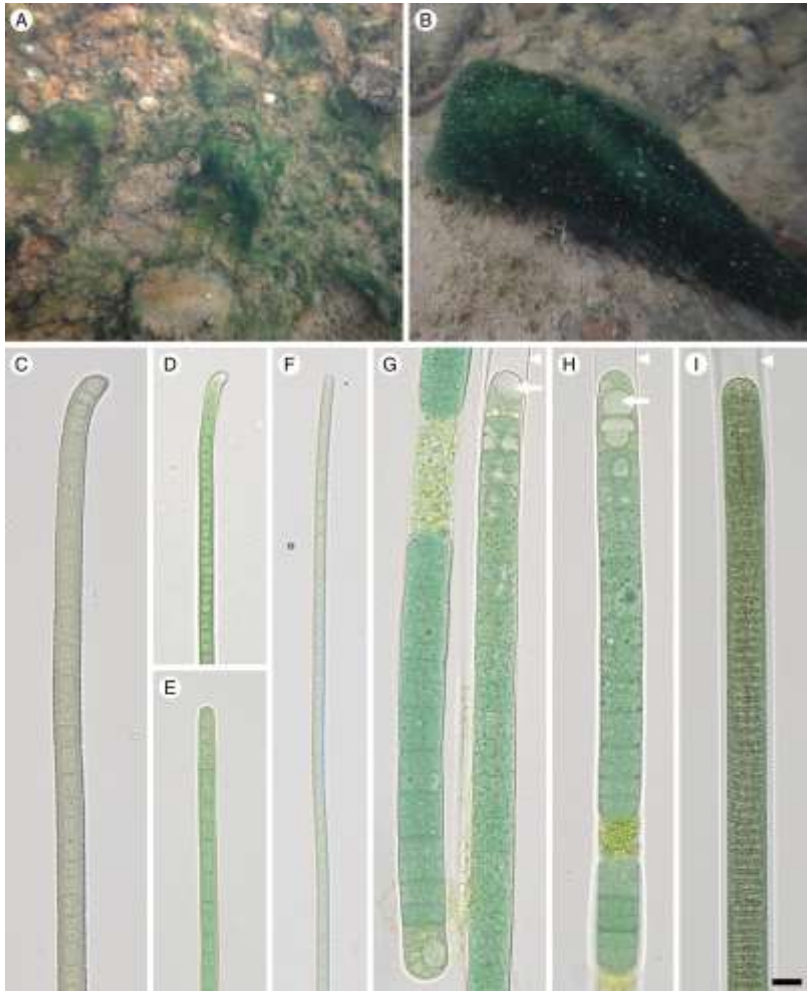
https://hcb-1.itrcweb.org/introduction/#3_1

Other Toxin-Producing Cyanobacteria

- ATX, SAX, microcystins, cylindrospermopsins, aplysiotoxin, lipopolysaccharides
- *Oscillatoria, Phormidium, Lyngbya sensu lato* (*Potamolinea, Kamptonema, Tenebriella*)

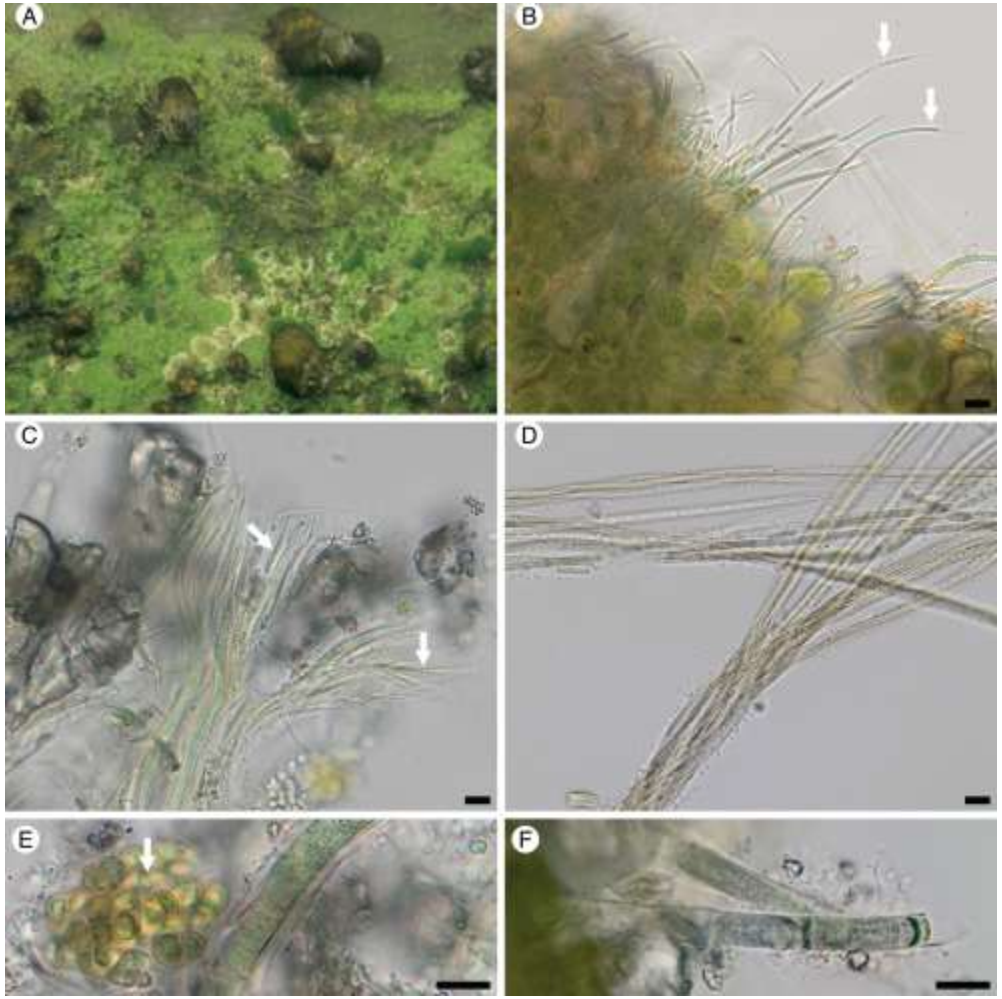




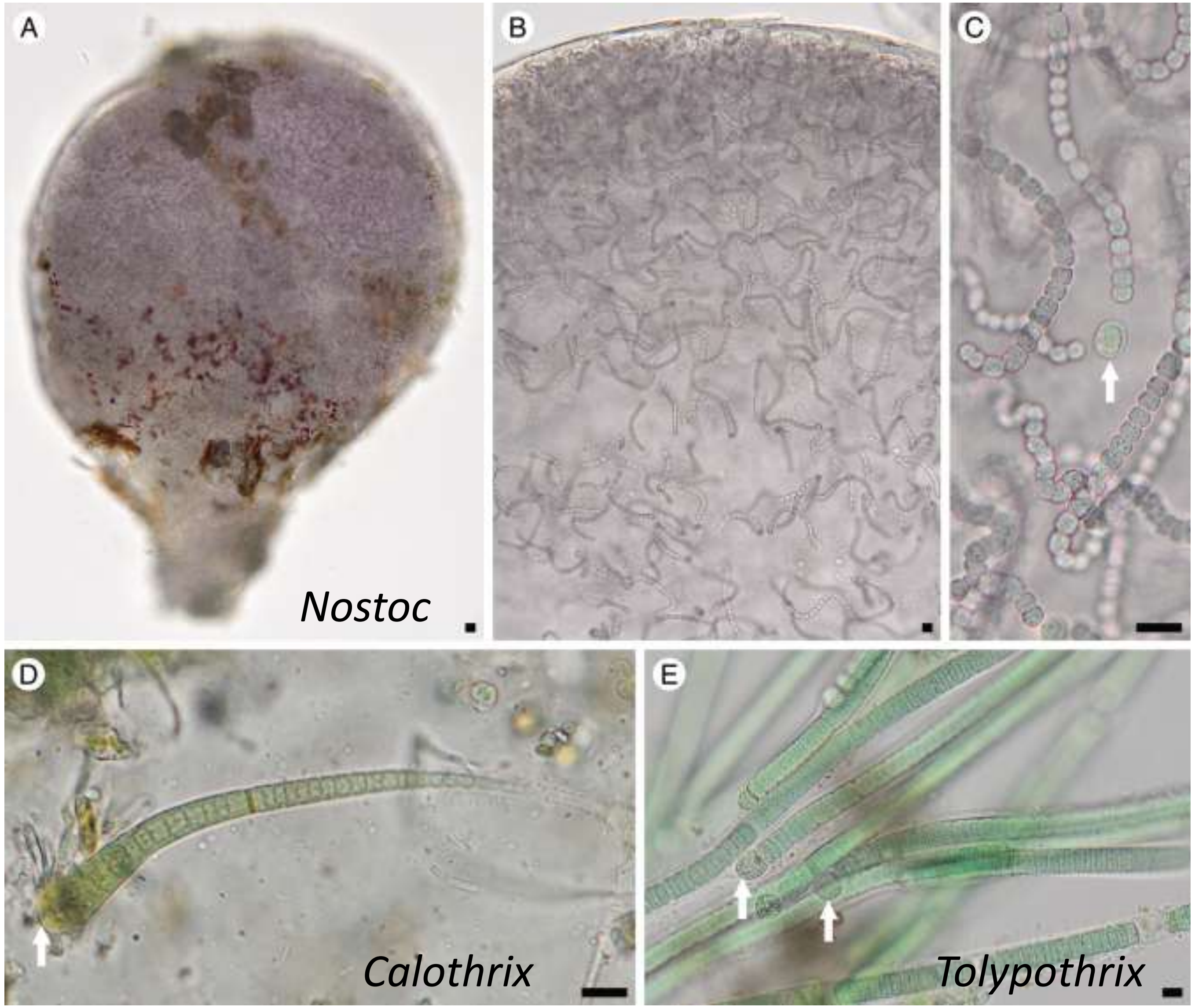


Crust-Forming Calcifying Cyanobacteria

- Aplysiotoxin, lipopolysaccharides
- Mixed communities of calcifying green algae and cyanobacterial were recorded in 60% of the samples
- *Schizothrix* spp., *Phormidium incrustatum, Homoeothrix (Phormidiochaete) crustacea*



Nitrogen-Fixing Cyanobacteria (Diazotrophs)



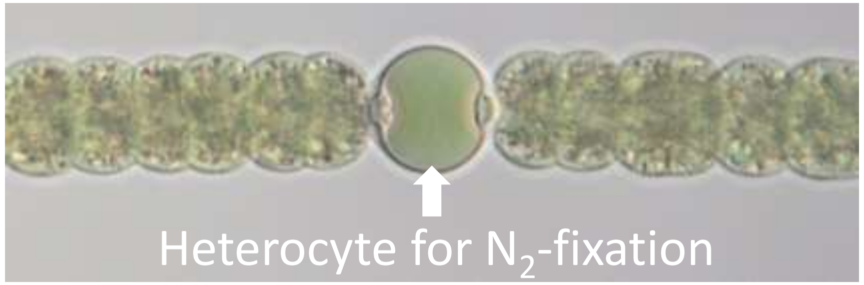
JUNE 2025

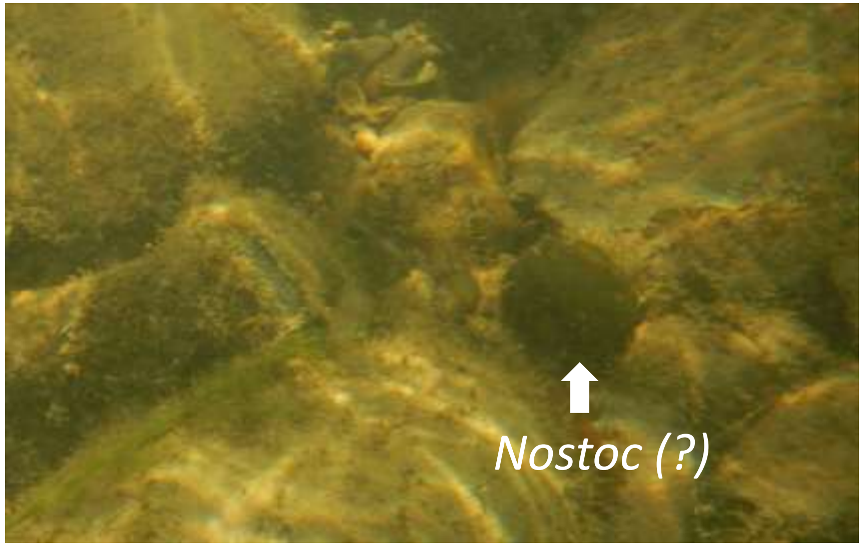
Rare, recorded in 2025 (June and August)

Nostoc – NF 5, 6

Calothrix – NF 6, 8, 10

Tolypothrix – SF 1





Nitrogen-Fixing Cyanobacteria (Diazotrophs)

Microseira wollei, AUGUST 2025 (SF upstream of Front Royal)

Conclusion

- **It is complicated!**
  - Hight species diversity of cyanobacteria
  - Unknown and potentially novel species
  - Multispecies mats with mixed toxicity
  - Effect of frequent storms
  - Year to year variation
- **Many unresolved questions!**
  - Environmental and anthropogenic drivers
  - Cyanobacterial responses and adaptations
  - Nitrogen-fixations
  - Best sampling and monitoring approaches

Thank you! Questions?

Email: rchris13@gmu.edu