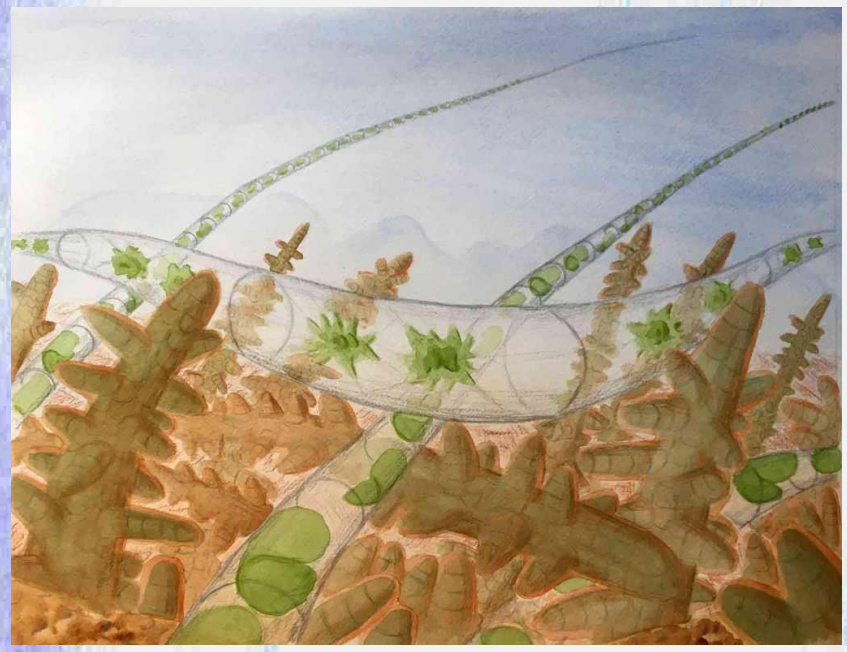
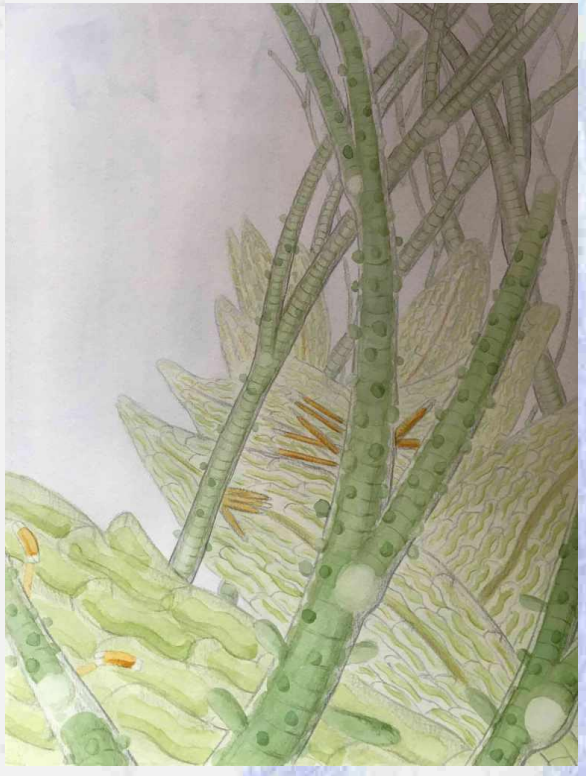
Benthic Cyanobacteria of the Lake District





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Martyn Kelly

Of Microscopes and Monsters ...

JULY 31, 2016 BY MARTYN KELLY

Both sides now ...

I diverted from my usual haunts in the upper River Ehen in Cumbria recently in order to explore Ennerdale Water in greater detail. I am used to see it from the western end as we do our fieldwork, but the length of the journey to and from the River Ehen means that we rarely have time to linger. Finally, however, we found a July day when we could circumnavigate the lake. "July day","Lake District" and "fieldwork" sounds like an intoxicating combination. However, the photograph above shows it was not quite as idyllic as it might have been (or, even, as it was on the day before). Hence the title of this post, borrowed from a beautiful Joni Mitchell song which includes the line "But clouds got in my way".

In the far past, the lakes of the Lake District were thought to have "evolved" at different speeds following their formation at the end of the last Ice Age. Ennerdale Water and Wastwater, surrounded by hard volcanic rocks which erode very slowly, were regarded as the two most "primitive" lakes, whilst Windermere and Esthwaite Water were thought to be the two most

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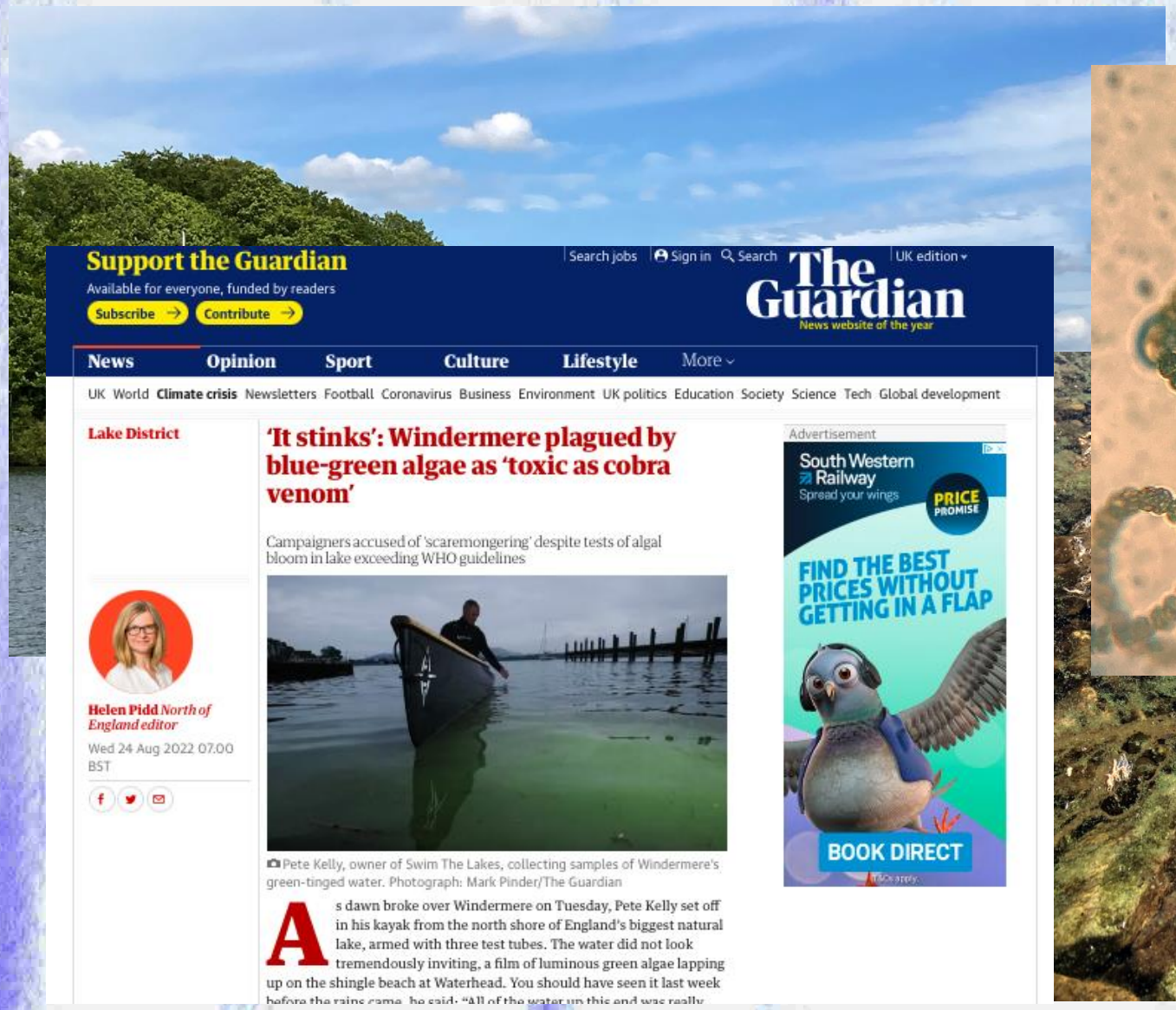
You think you know all about Cyanobacteria …



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Lake District

'It stinks': Windermere plagued by blue-green algae as 'toxic as cobra venom'

Campaigners accused of 'scaremongering' despite tests of algal bloom in lake exceeding WHO guidelines

Pete Kelly, owner of Swim The Lakes, collecting samples of Windermere's green-tinged water. Photograph: Mark Pinder/The Guardian

Helen Pidd *North of England editor*

Wed 24 Aug 2022 07.00 BST

As dawn broke over Windermere on Tuesday, Pete Kelly set off in his kayak from the north shore of England's biggest natural lake, armed with three test tubes. The water did not look tremendously inviting, a film of luminous green algae lapping up on the shingle beach at Waterhead. You should have seen it last week before the rains came, he said: "All of the water up this end was really

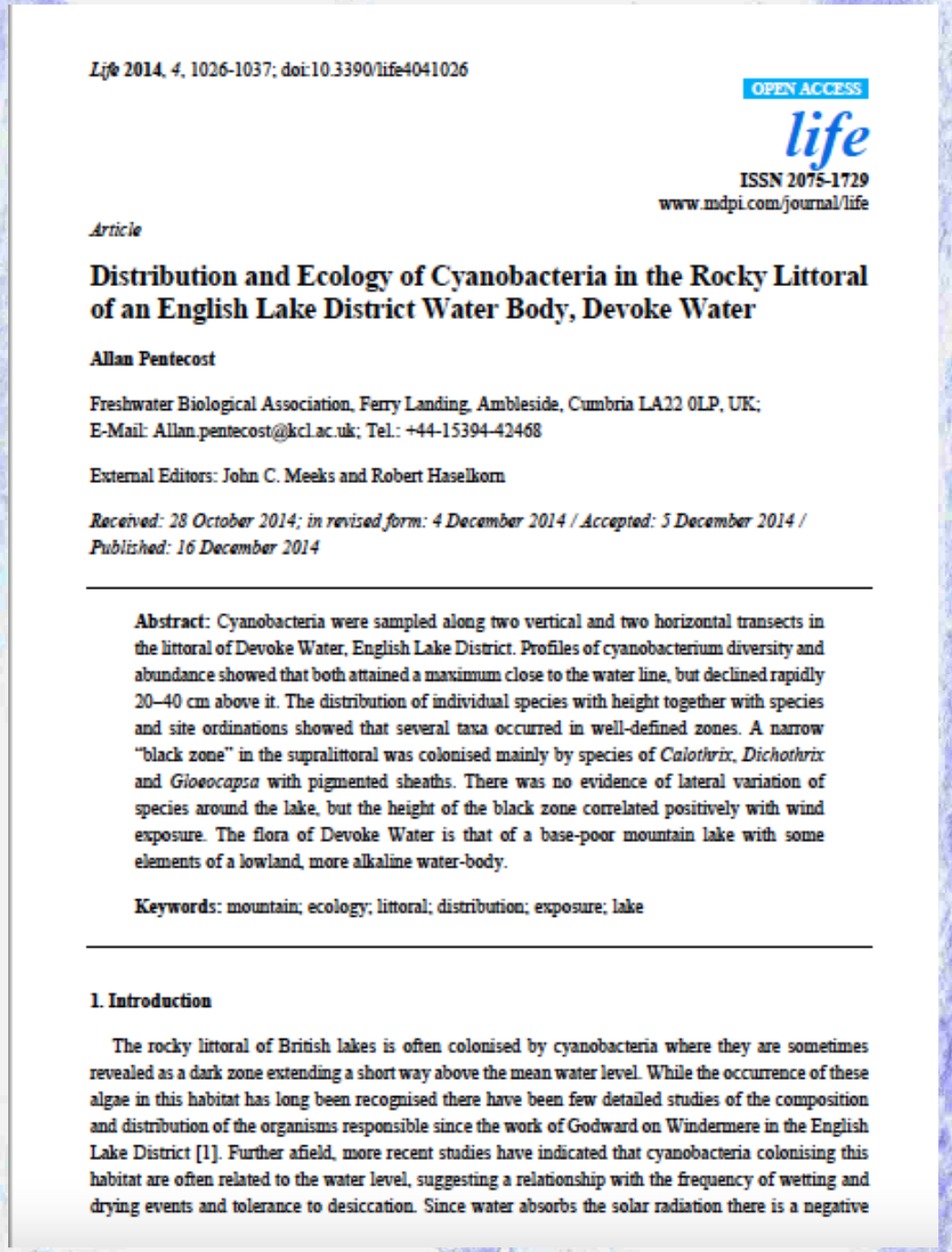
Think again …

- This talk is about Cyanobacteria in benthic habitats in the Lake District.
- Much less well studied than their planktonic counterparts

Thanks to:

Financial support: United Utilities

Fieldwork support: Ben Surridge (University of Lancaster), Heather Kelly (University of Durham)



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Article

Distribution and Ecology of Cyanobacteria in the Rocky Littoral of an English Lake District Water Body, Devoke Water

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External Editors: John C. Meeks and Robert Haselkorn

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Abstract: Cyanobacteria were sampled along two vertical and two horizontal transects in the littoral of Devoke Water, English Lake District. Profiles of cyanobacterium diversity and abundance showed that both attained a maximum close to the water line, but declined rapidly 20–40 cm above it. The distribution of individual species with height together with species and site ordinations showed that several taxa occurred in well-defined zones. A narrow "black zone" in the supralittoral was colonised mainly by species of *Calothrix*, *Dichothrix* and *Gloeocapsa* with pigmented sheaths. There was no evidence of lateral variation of species around the lake, but the height of the black zone correlated positively with wind exposure. The flora of Devoke Water is that of a base-poor mountain lake with some elements of a lowland, more alkaline water-body.

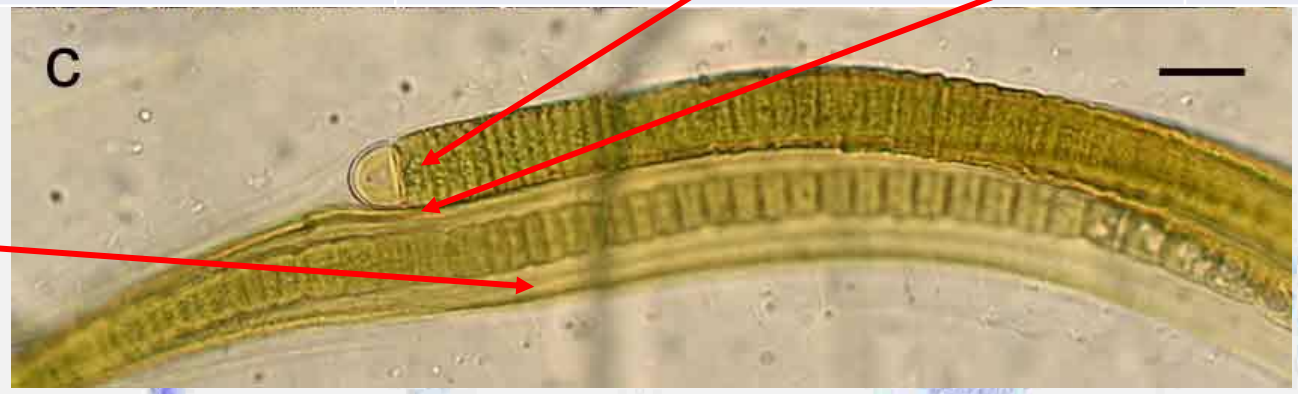
Keywords: mountain; ecology; littoral; distribution; exposure; lake

1. Introduction

The rocky littoral of British lakes is often colonised by cyanobacteria where they are sometimes revealed as a dark zone extending a short way above the mean water level. While the occurrence of these algae in this habitat has long been recognised there have been few detailed studies of the composition and distribution of the organisms responsible since the work of Godward on Windermere in the English Lake District [1]. Further afield, more recent studies have indicated that cyanobacteria colonising this habitat are often related to the water level, suggesting a relationship with the frequency of wetting and drying events and tolerance to desiccation. Since water absorbs the solar radiation there is a negative

Traditional (morphological) classification

Order	**Description**	
Chroococcales	single cells or cells loosely-bound into irregular gelatinous colonies	
Oscillatoriales	filamentous forms lacking heterocysts	
Nostocales	filamentous forms with heterocysts	(unbranched or false-branched)
(Stigonematales)		(true-branched)

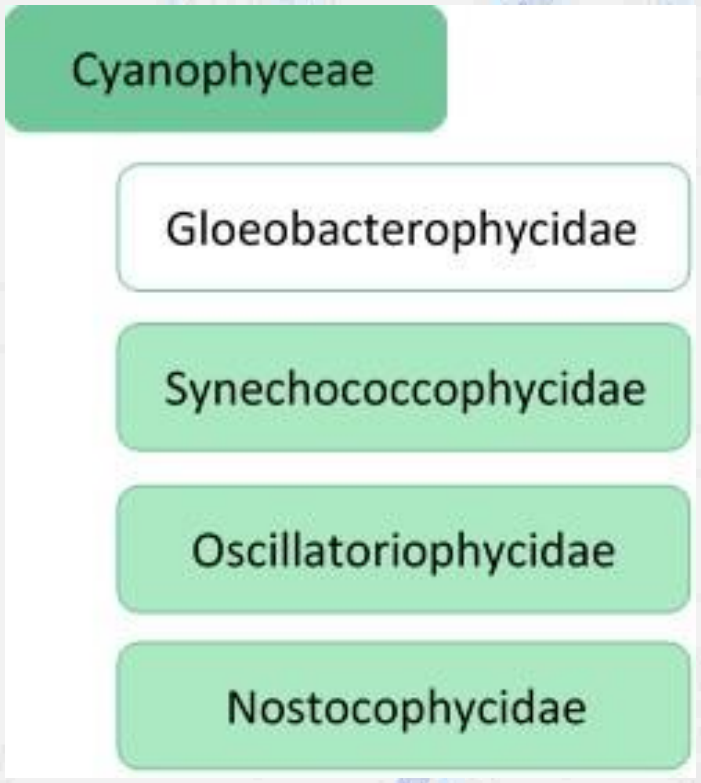


Sheath with scytonemin

No gas vacuoles

Rivularia

Modern (molecular) classification



(not found in UK or Ireland)

Chrococcales

Oscillatoriales

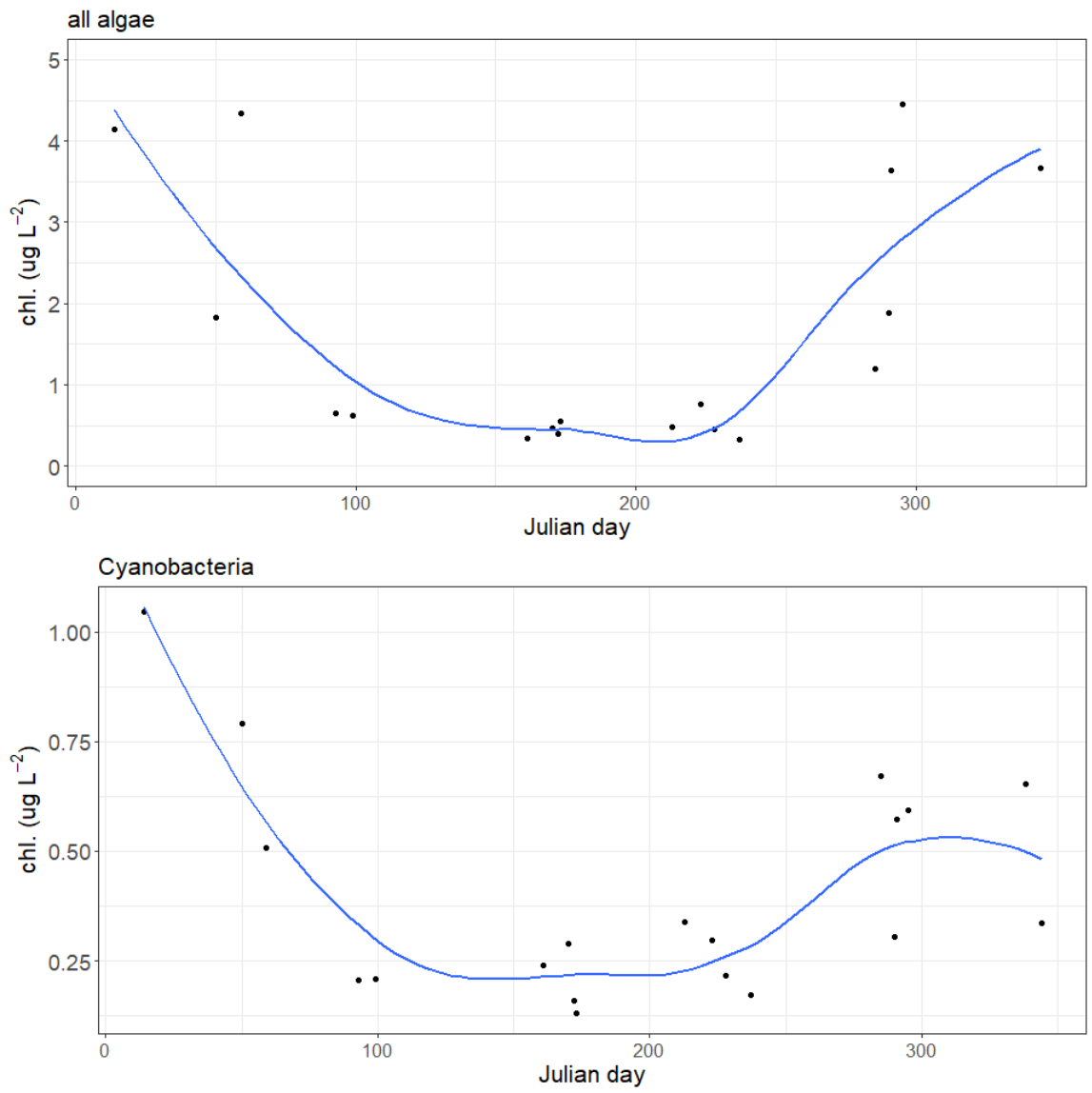
Nostocales

https://microscopesandmonsters.wordpress.com/2020/02/29/shuffling-the-pack/

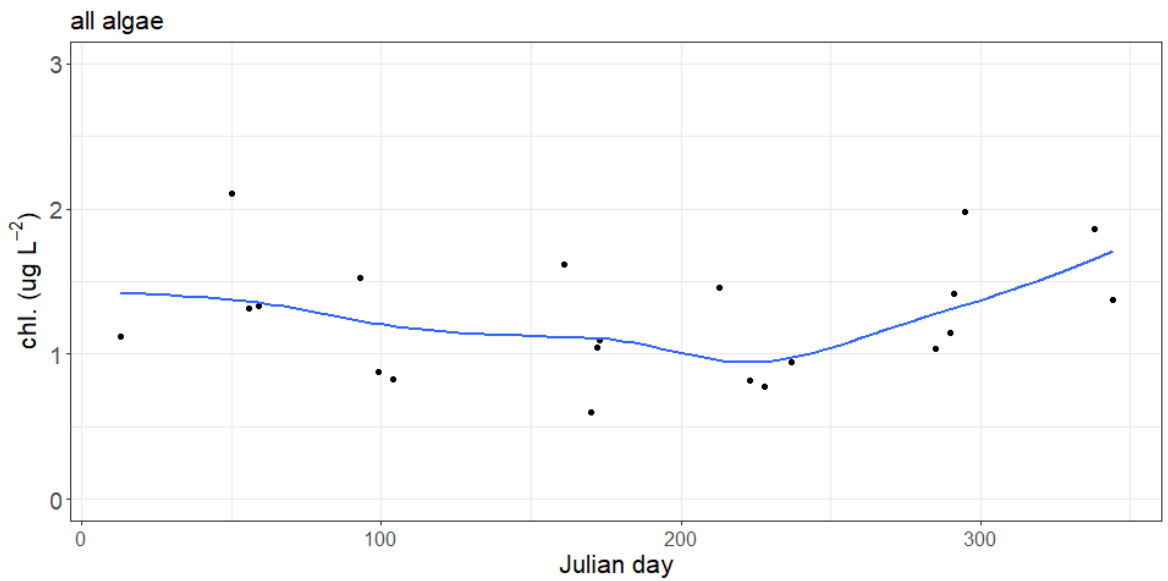
Annual variation in biomass

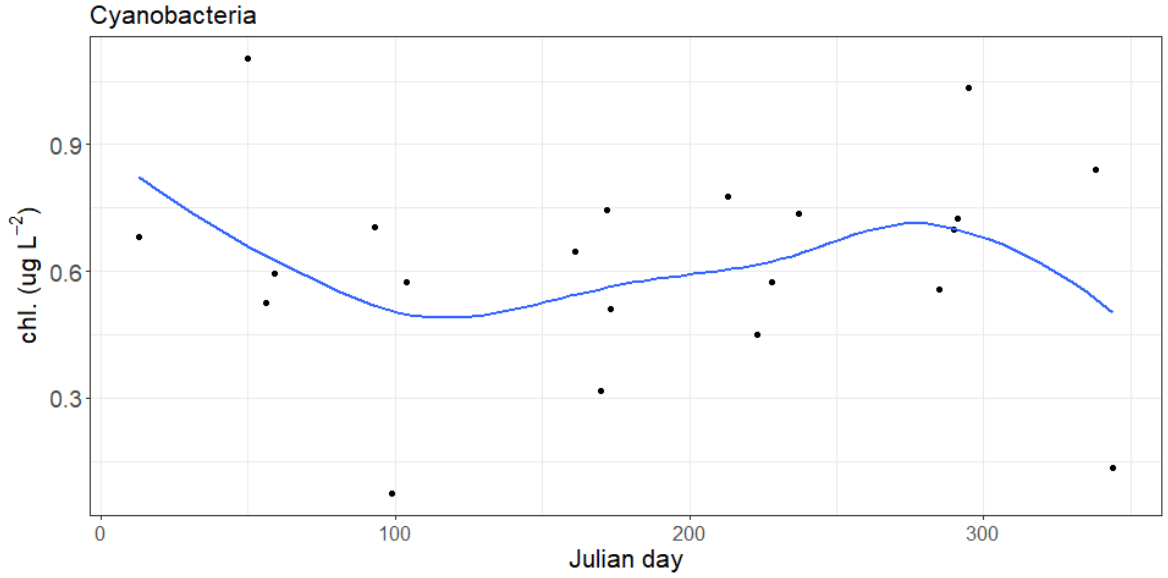
- Six visits per year since 2019
- Five cobbles from littoral zone
- Measured with BenthoTorch
- Differentiates three algal groups:
  - “Green algae”
  - “Diatoms”
  - “Cyanobacteria”

Ennerdale Water

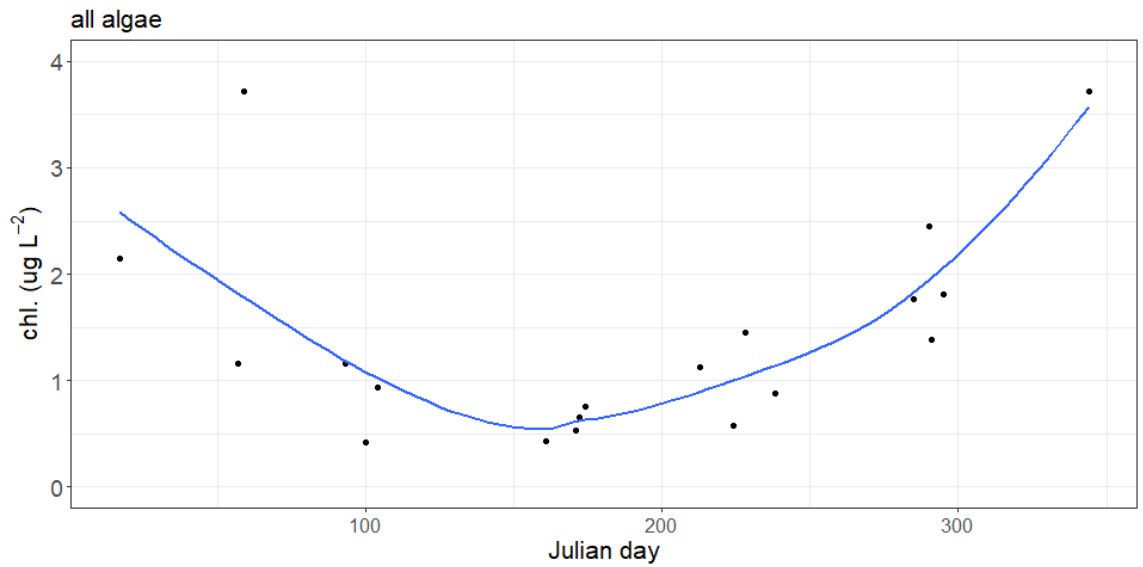


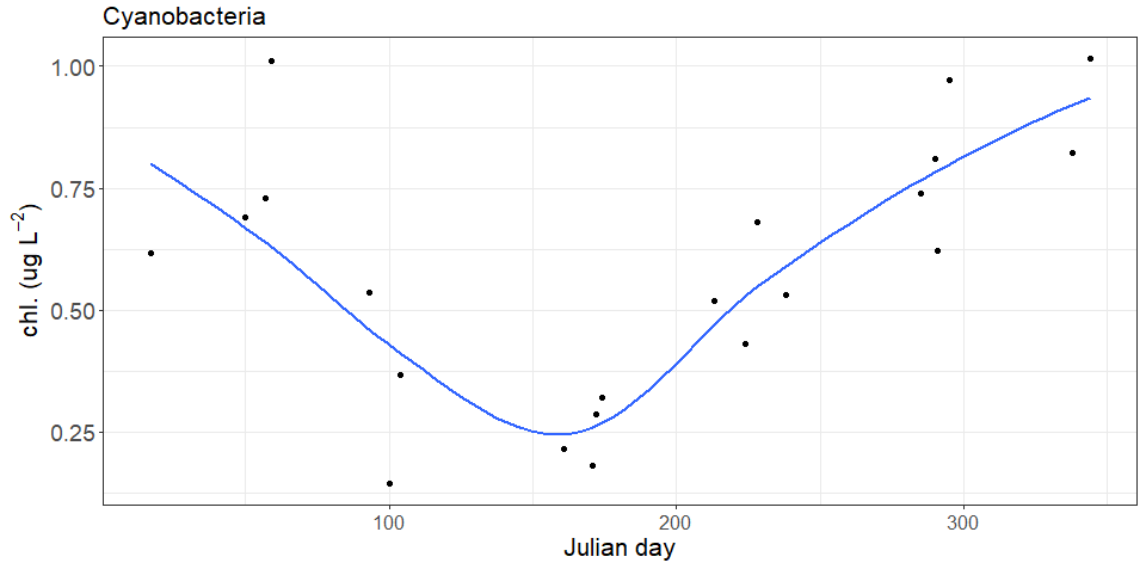
Crummock Water



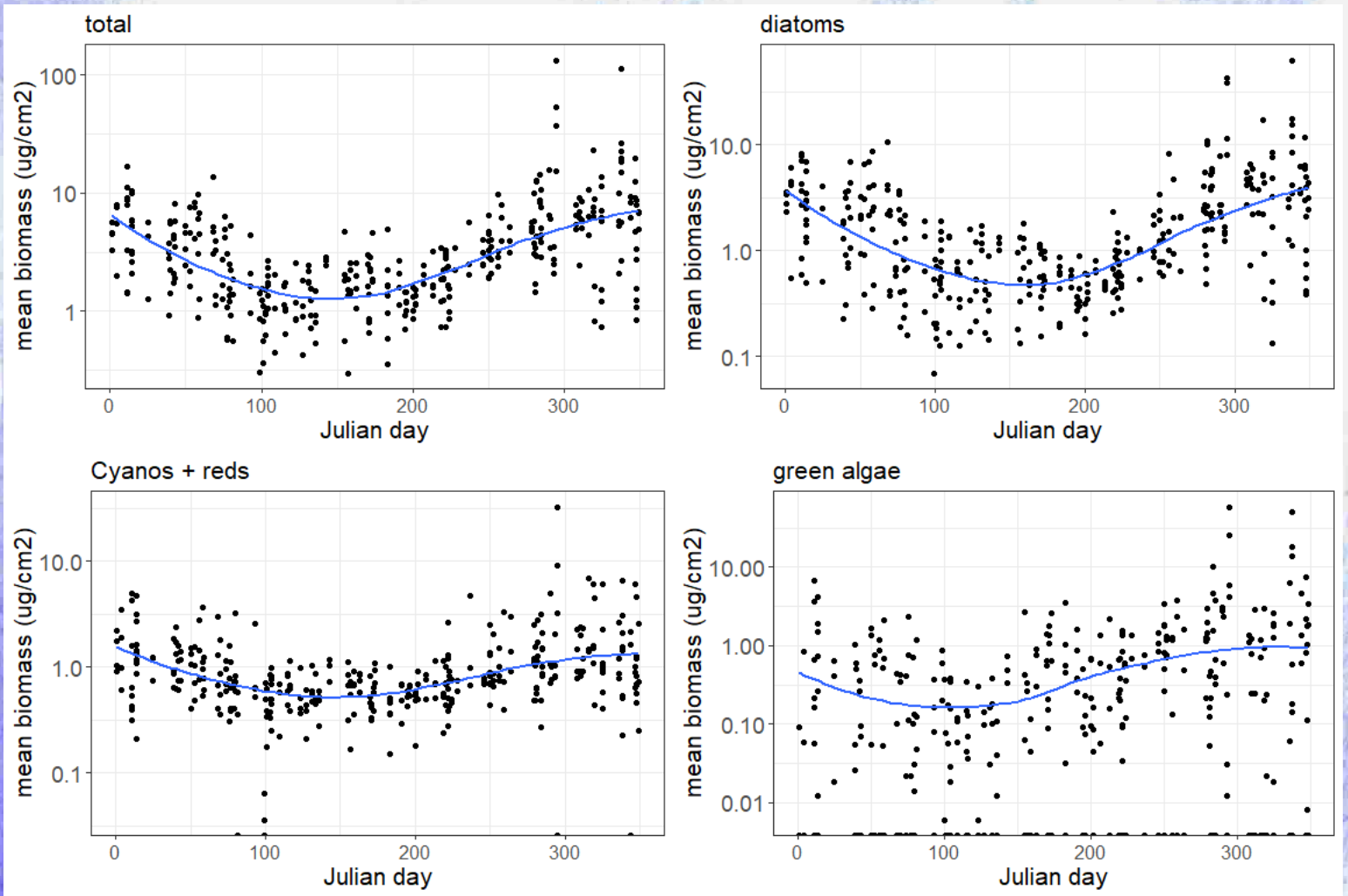


Wastwater


all algae
chl. (ug L^{-2})
0
1
2
3
4
100
200
300
Julian day

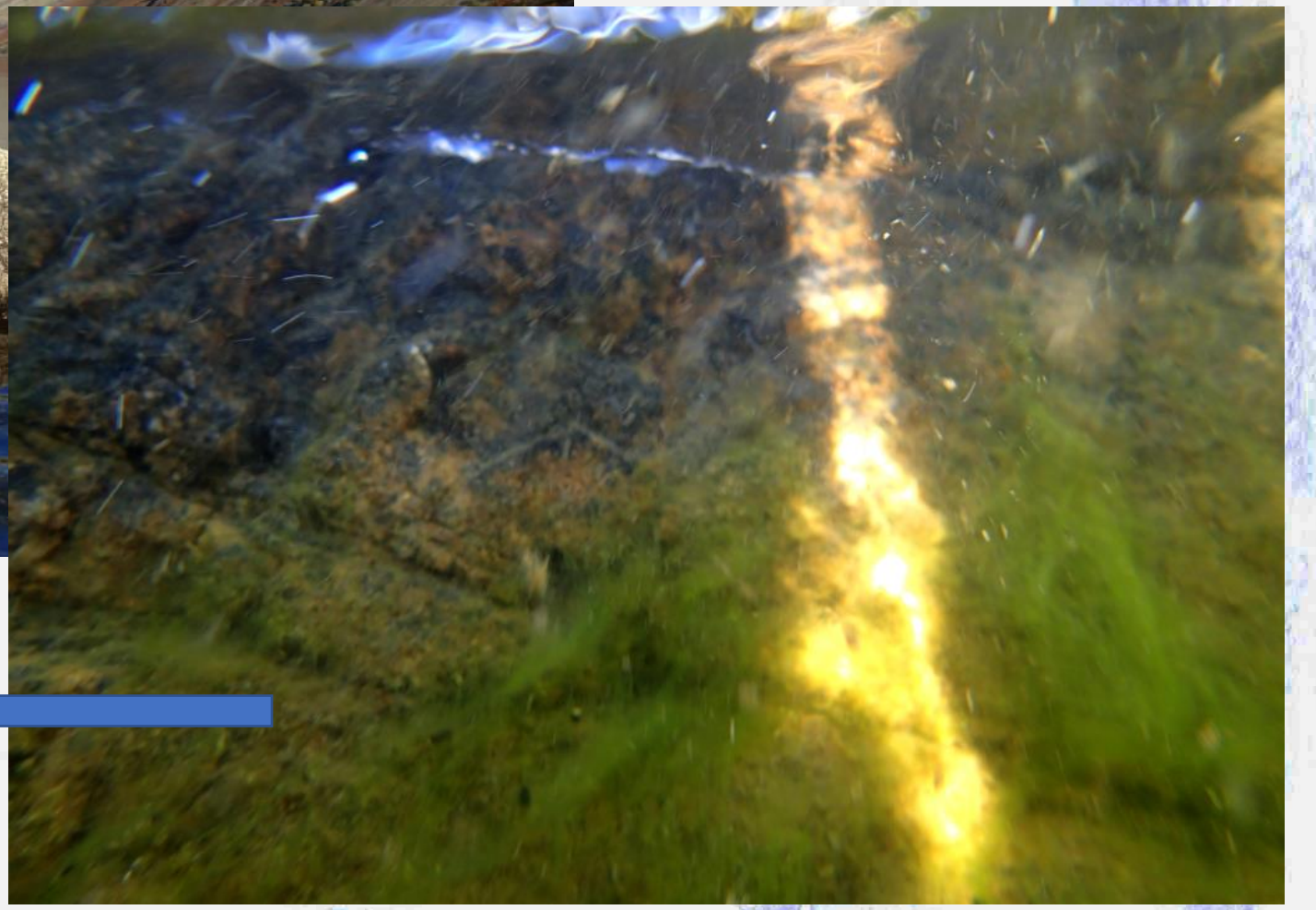

Cyanobacteria
chl. (ug L^{-2})
0.25
0.50
0.75
1.00
100
200
300
Julian day

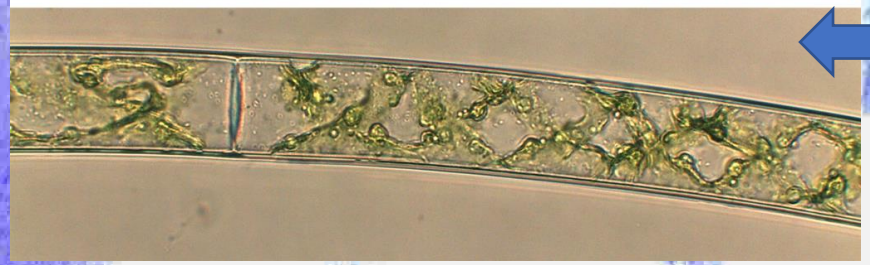
Similar patterns in rivers downstream of lakes …



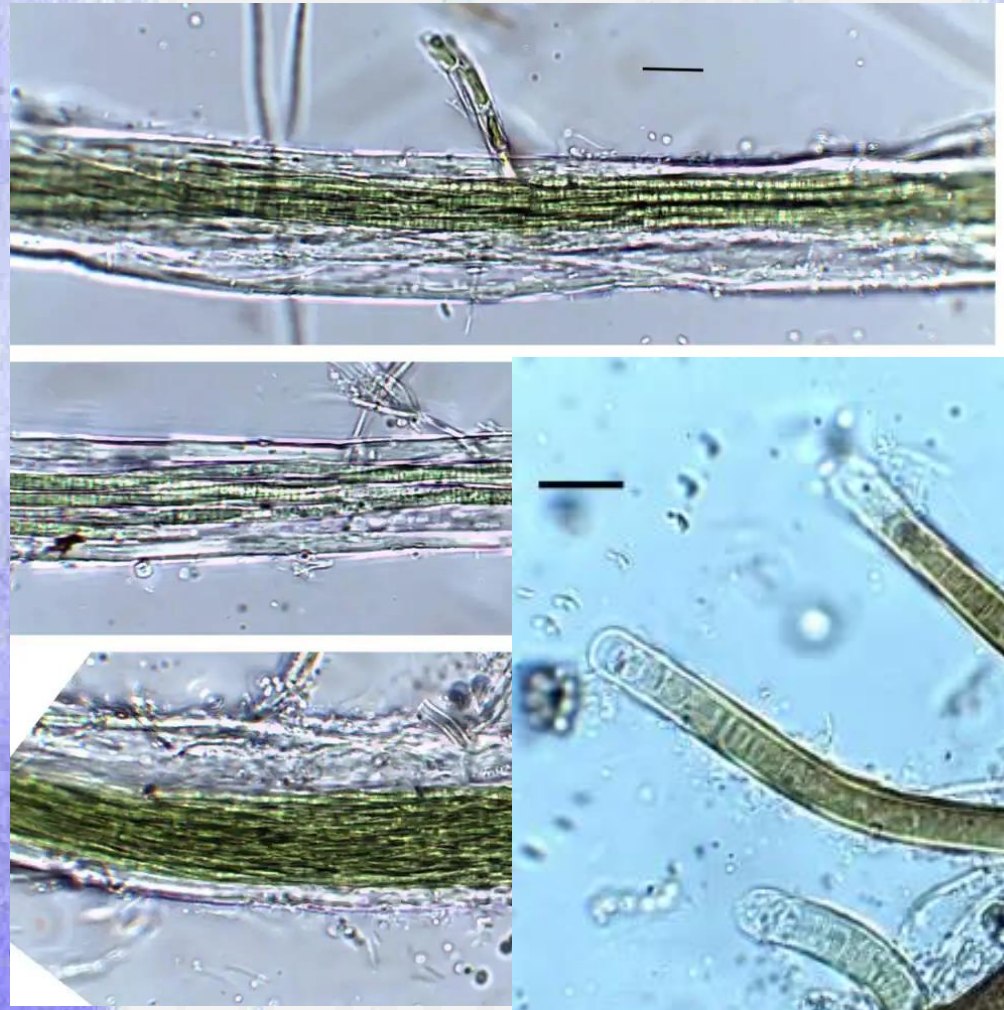
River Ehen
(note log scale)

August 2022





Cyanobacteria from Wastwater's splash zone



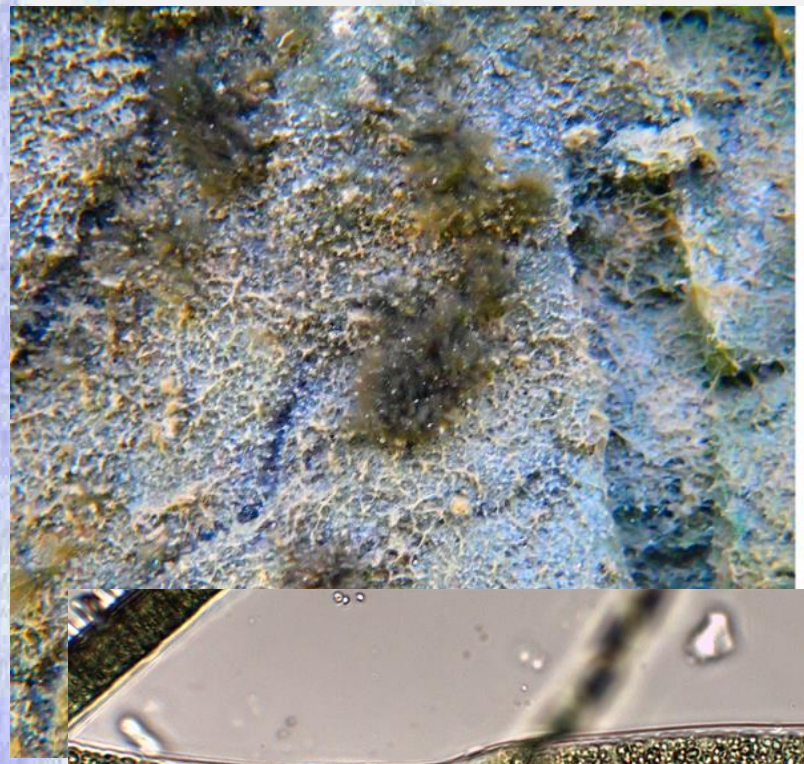
Microcoleus lacustris

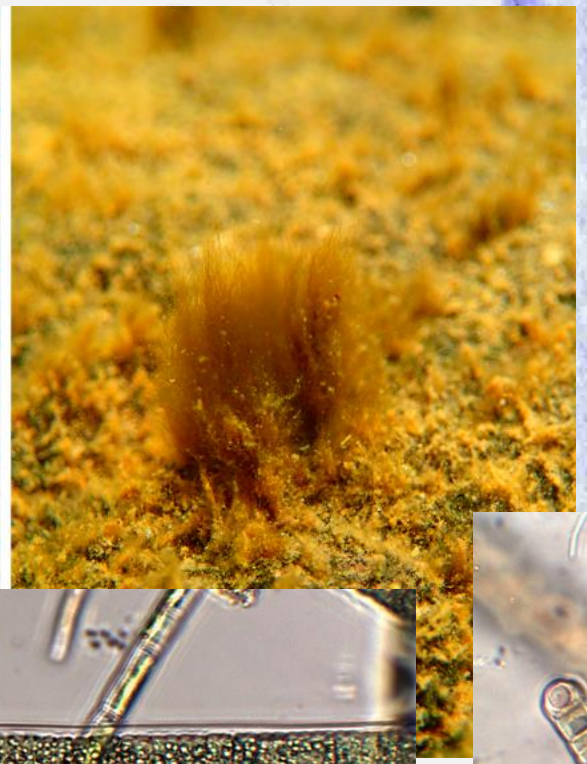
Scytonema sp.

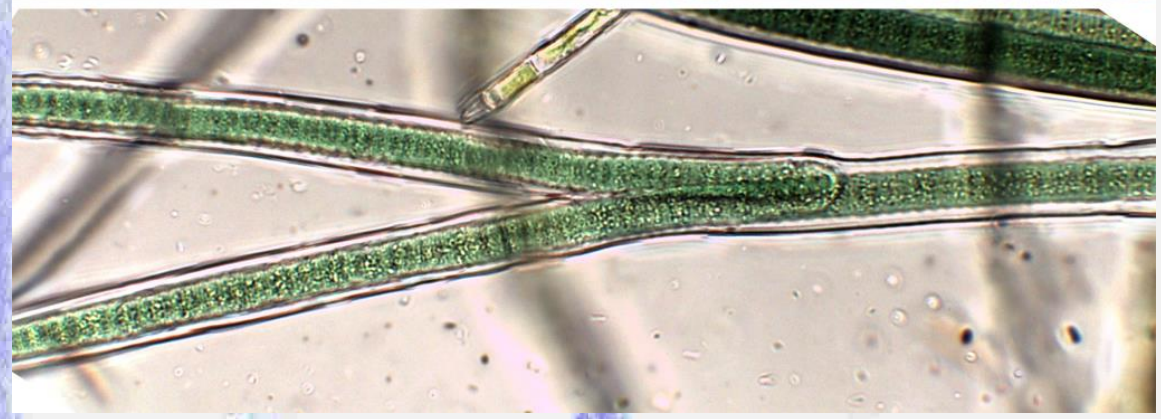
Calothrix cf. *fusca*

October 2022

Tolypothrix distorta var. *penicillatus*





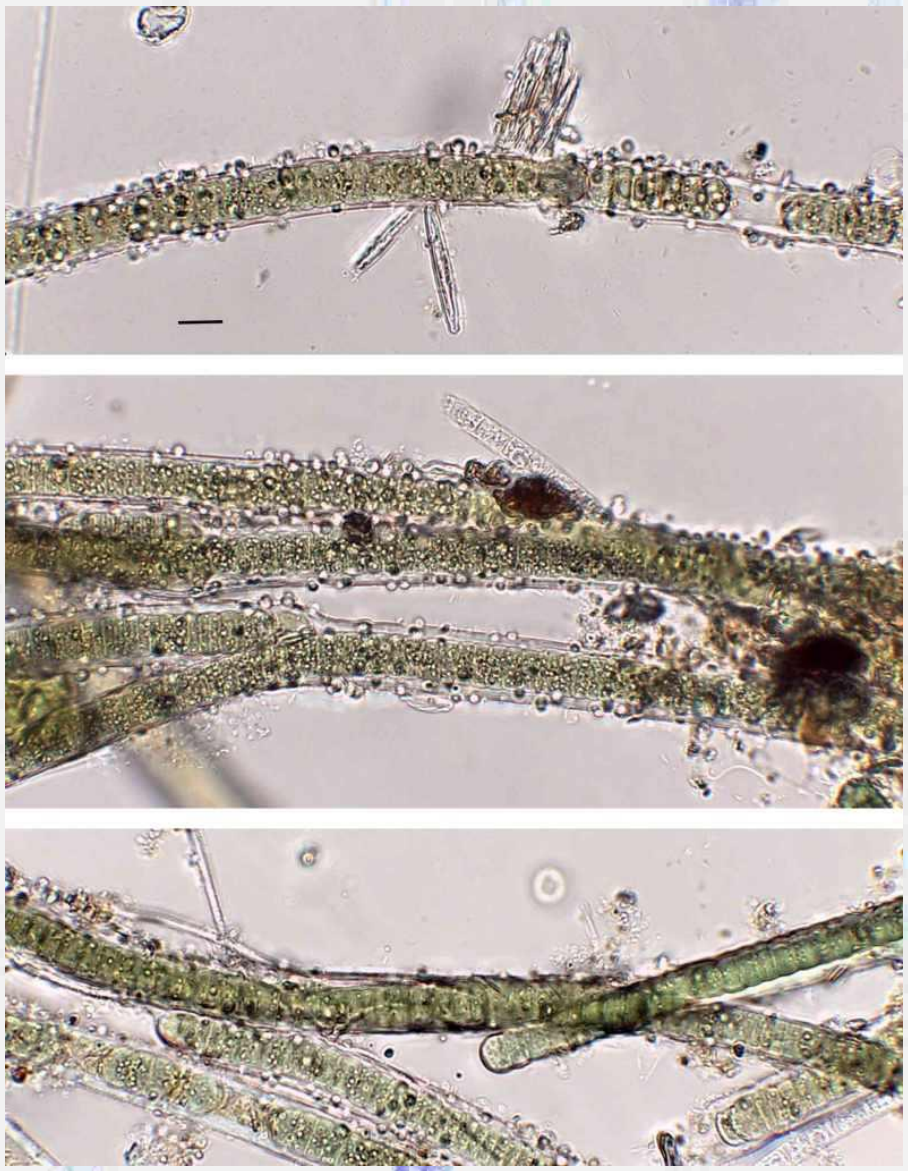


River Irt

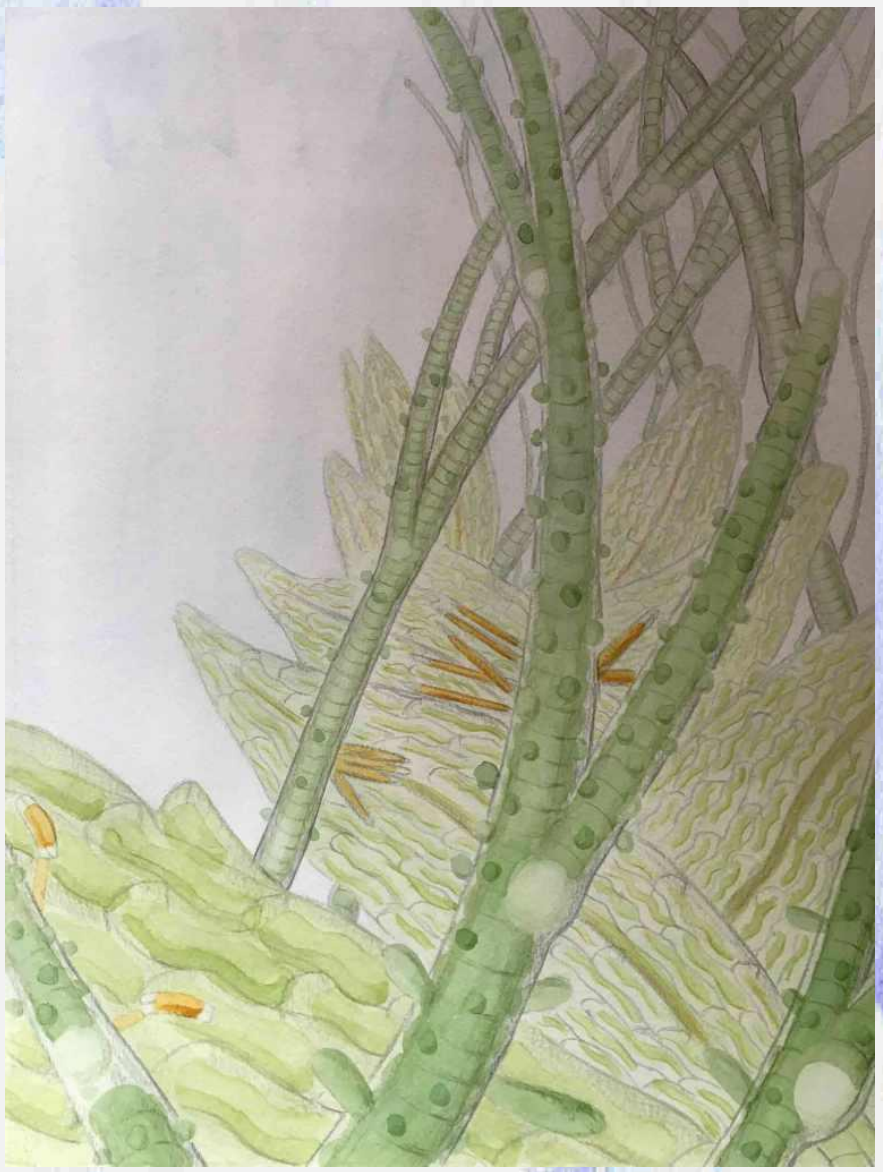
Tolypothrix intertwined moss and Cyanobacteria

Tolypothrix distorta var. *penicillatus*

With epiphytic *Chamaesiphon* sp.

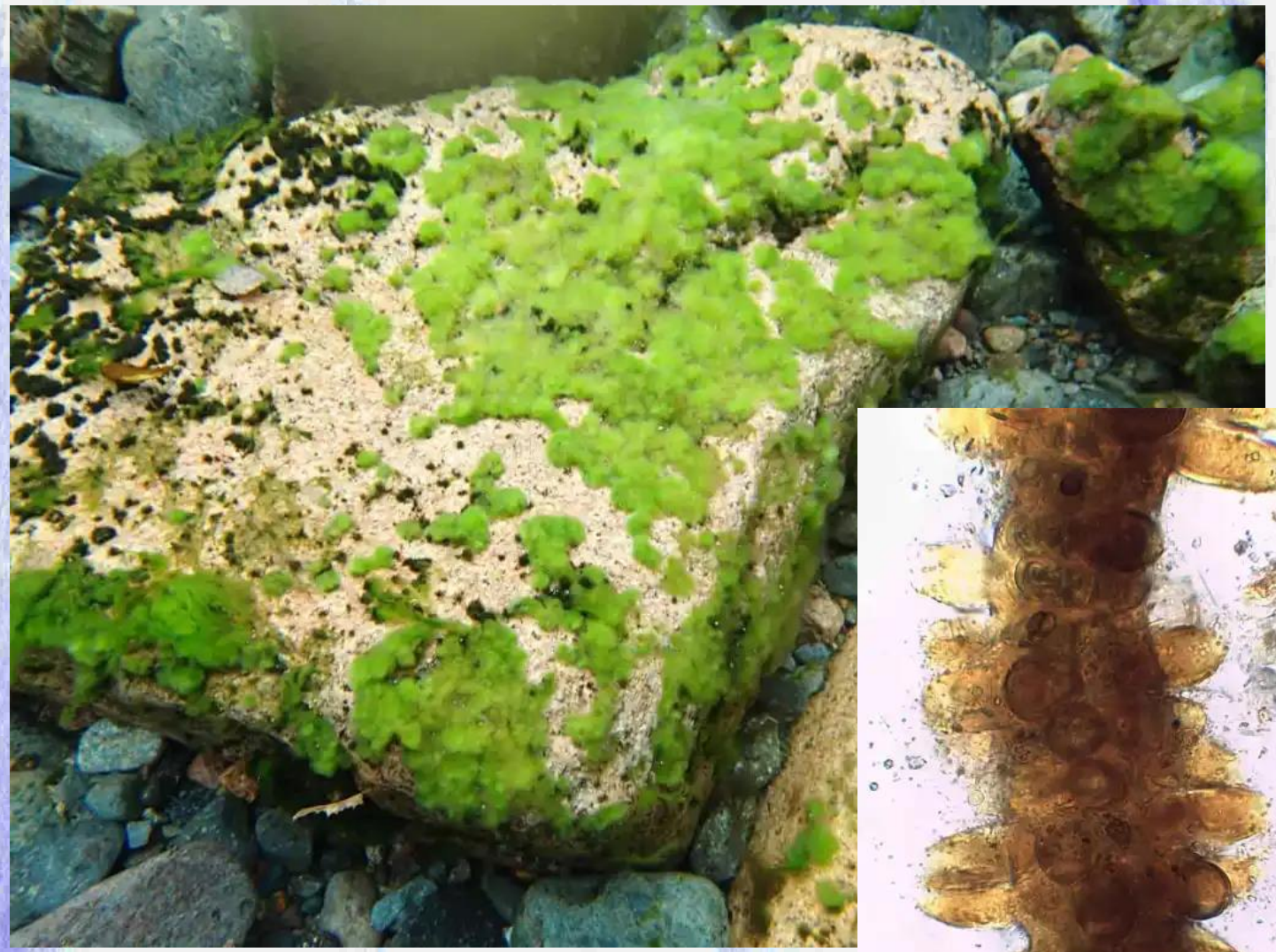


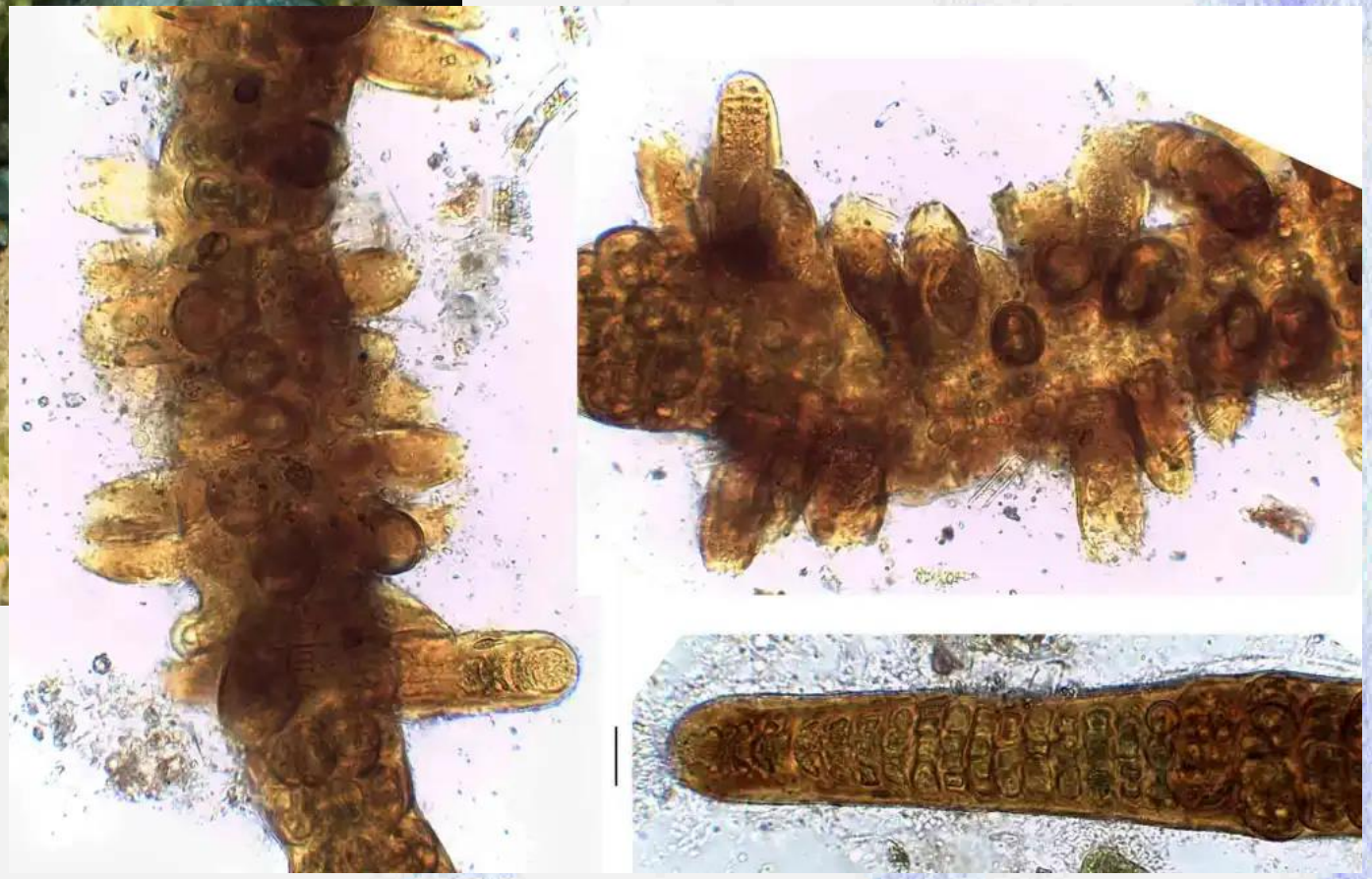
Intertwined with *Racomitrium aciculare*

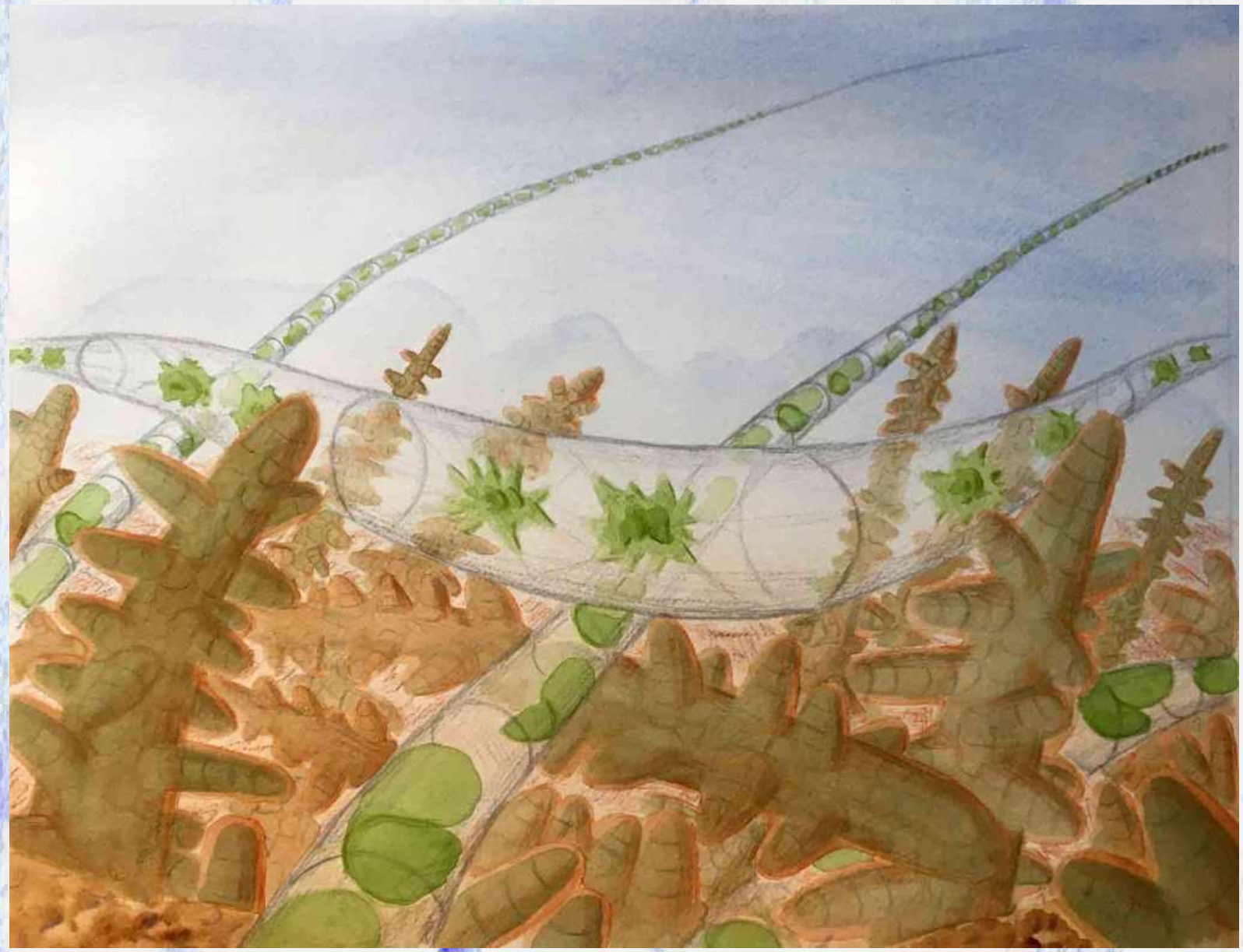


River Liza

Stigonema mamillosum

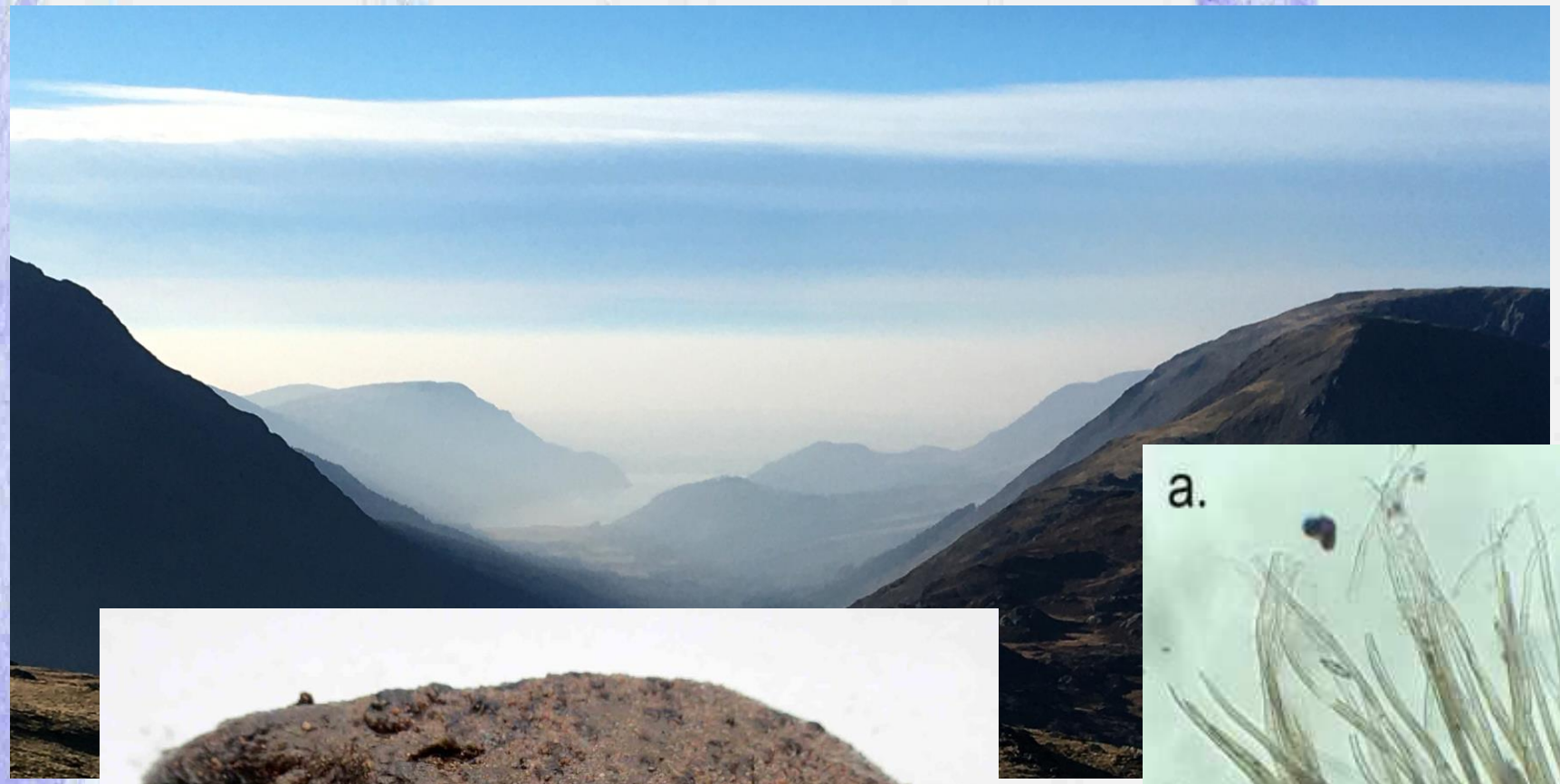




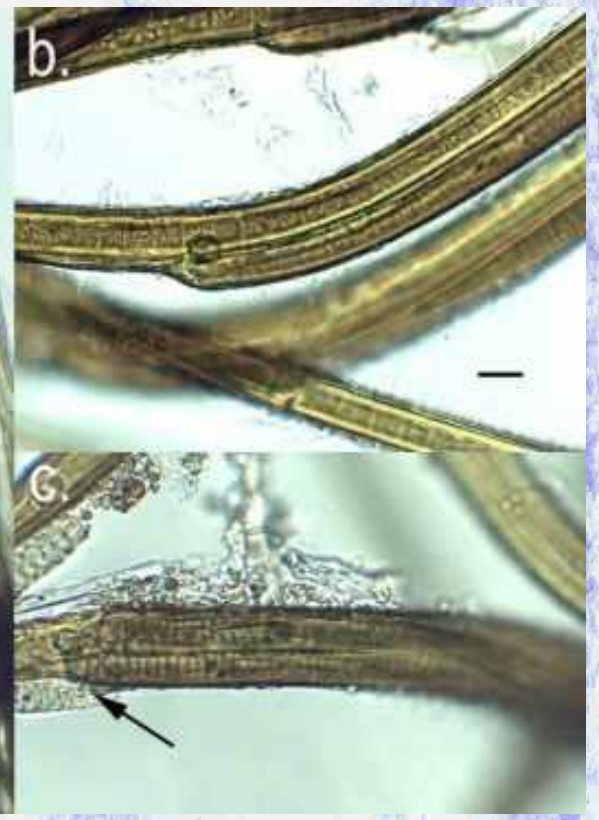


Stigonema mamillosum creates a “nursery” for green algal filaments (*Zygnema, Ulothrix, Bulbochaete*)

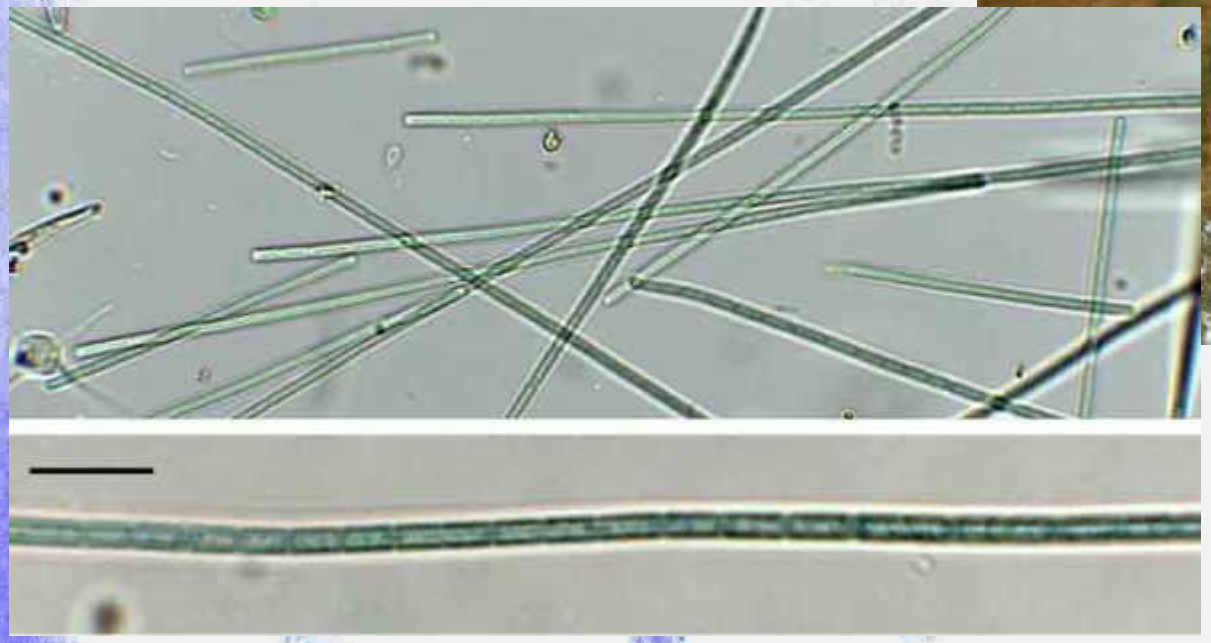
Ennerdale Water



Rivularia cf. *biasolettiana*



River Ehen, c. 200m downstream from lake, August 2018



Scale bar: 10 µm

Closing thoughts

- Spatially and temporally patchy
  - Some are “perennial”; others come and go
- Knowledge is also very patchy
  - (compared to what we know about phytoplankton)
  - Complicated by taxonomic revisions and
  - Limitations of light microscopy ...
- Fertile territory for metabarcoding study?
  - How will we deal with their patchiness?
- What do they contribute to N, P and C cycling (and tastes and odours) in nutrient-poor lakes?

Thank you

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S. Elliot, Four Quartets

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