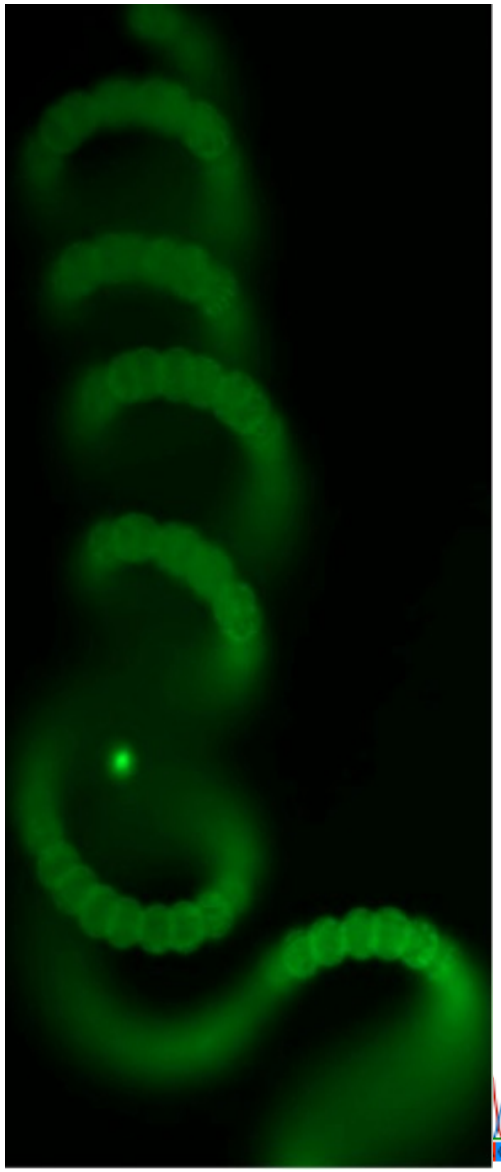

Woronichinia and *Limnoraphis* are lesser known, yet quite widespread, components of CyanoHABs in the Pacific NW

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Robin Matthews

Professor Emerita, Western Washington University

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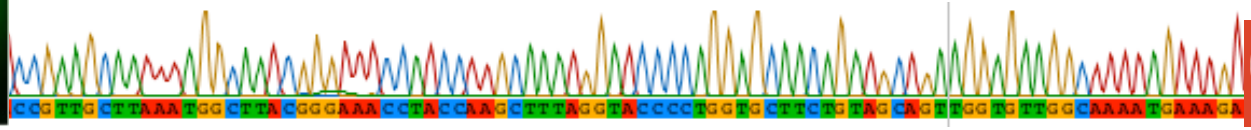
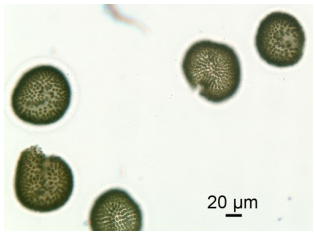
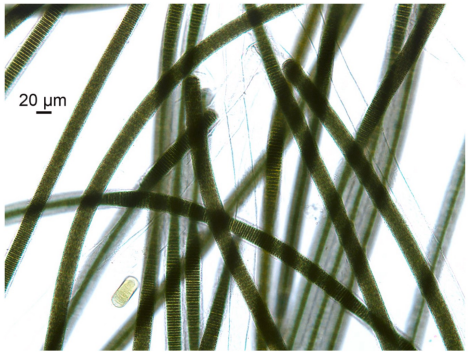


Oregon State University

Woronichinia naegeliana and *Limnoraphis* blooms sampled for genome sequencing

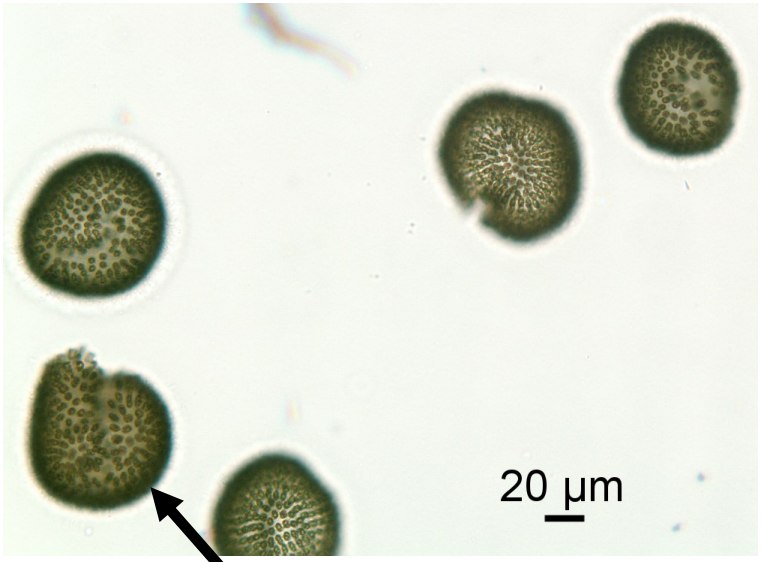


Woronichinia naegeliana

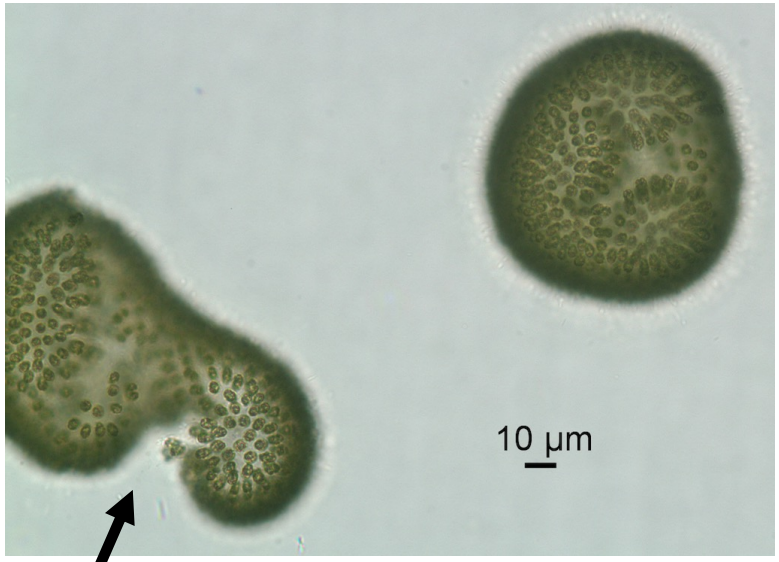


Limnoraphis

Woronichinia naegeliana from Wiser Lake, 25 September, 2018

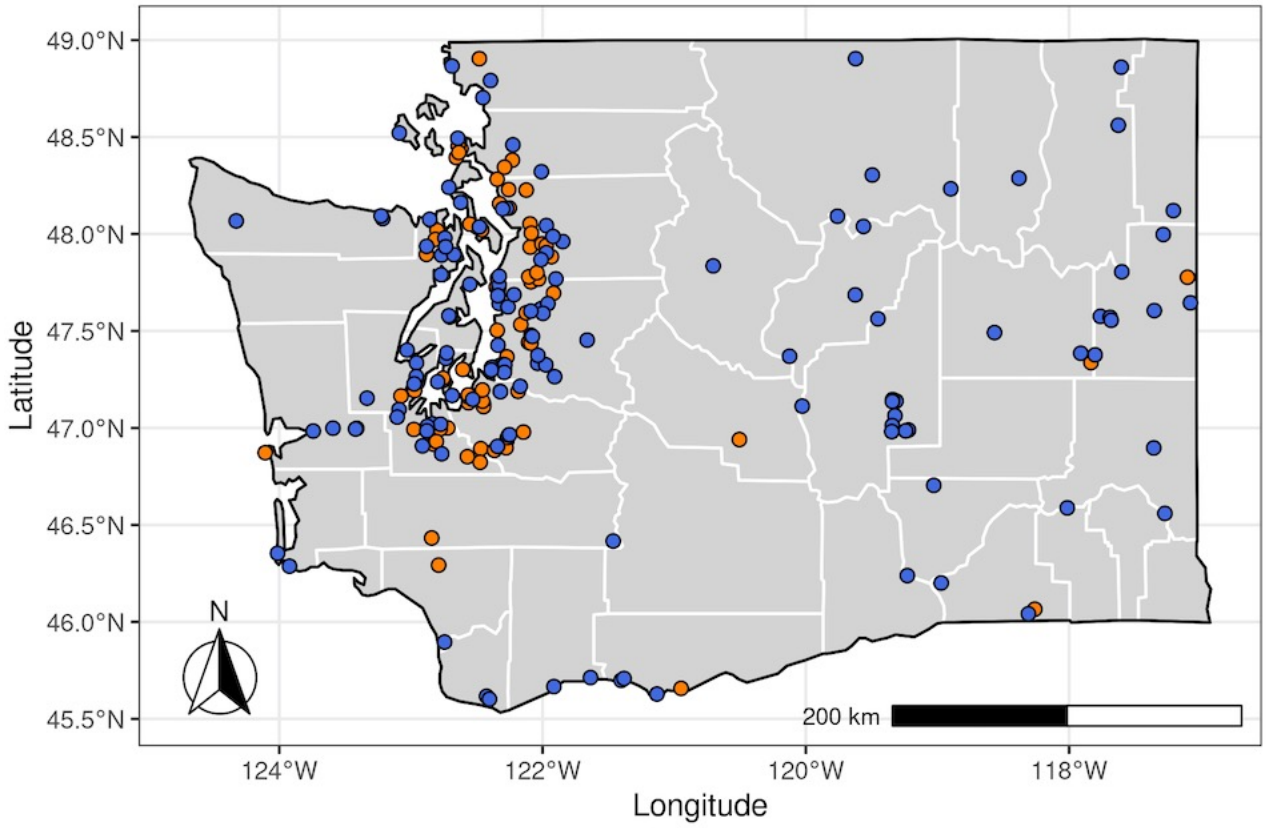


Cells at periphery of colony



Colony in process of dividing

Woronichinia occurrences in Washington lakes, 2007-2019

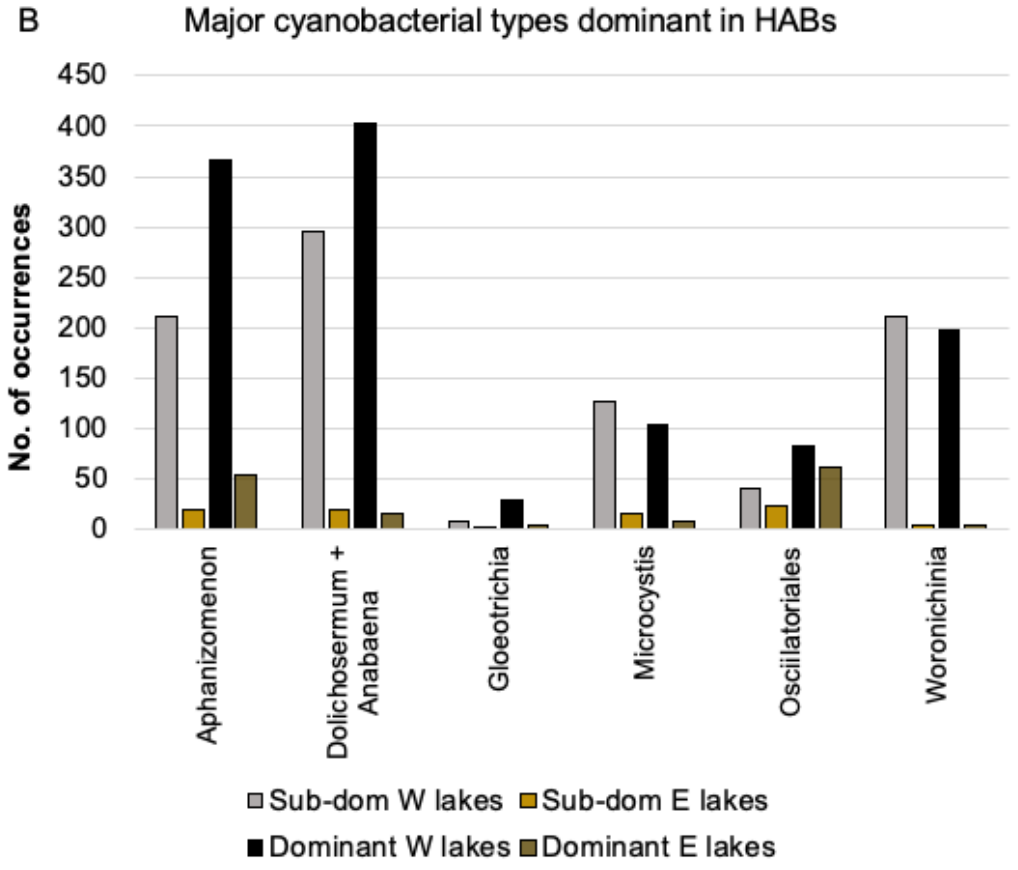


Lakes sampled

Lakes with *Woronichinia* dominant or sub-dominant in at least one sample

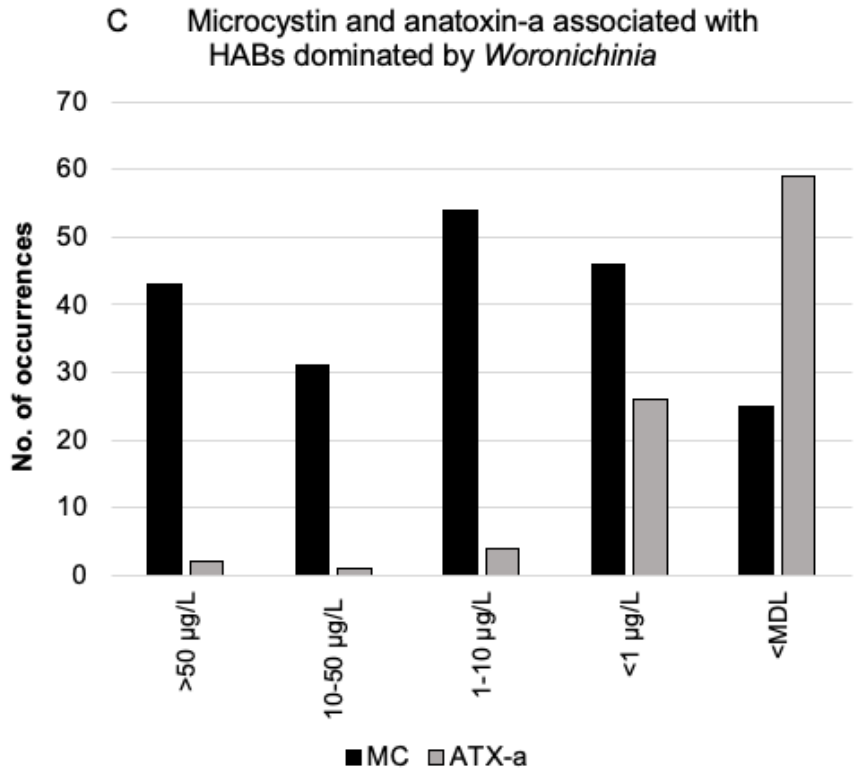
Data source: https://www.nwtoxicalgae.org/Data.aspx

Woronichinia is very common in western Washington: 2007-2019



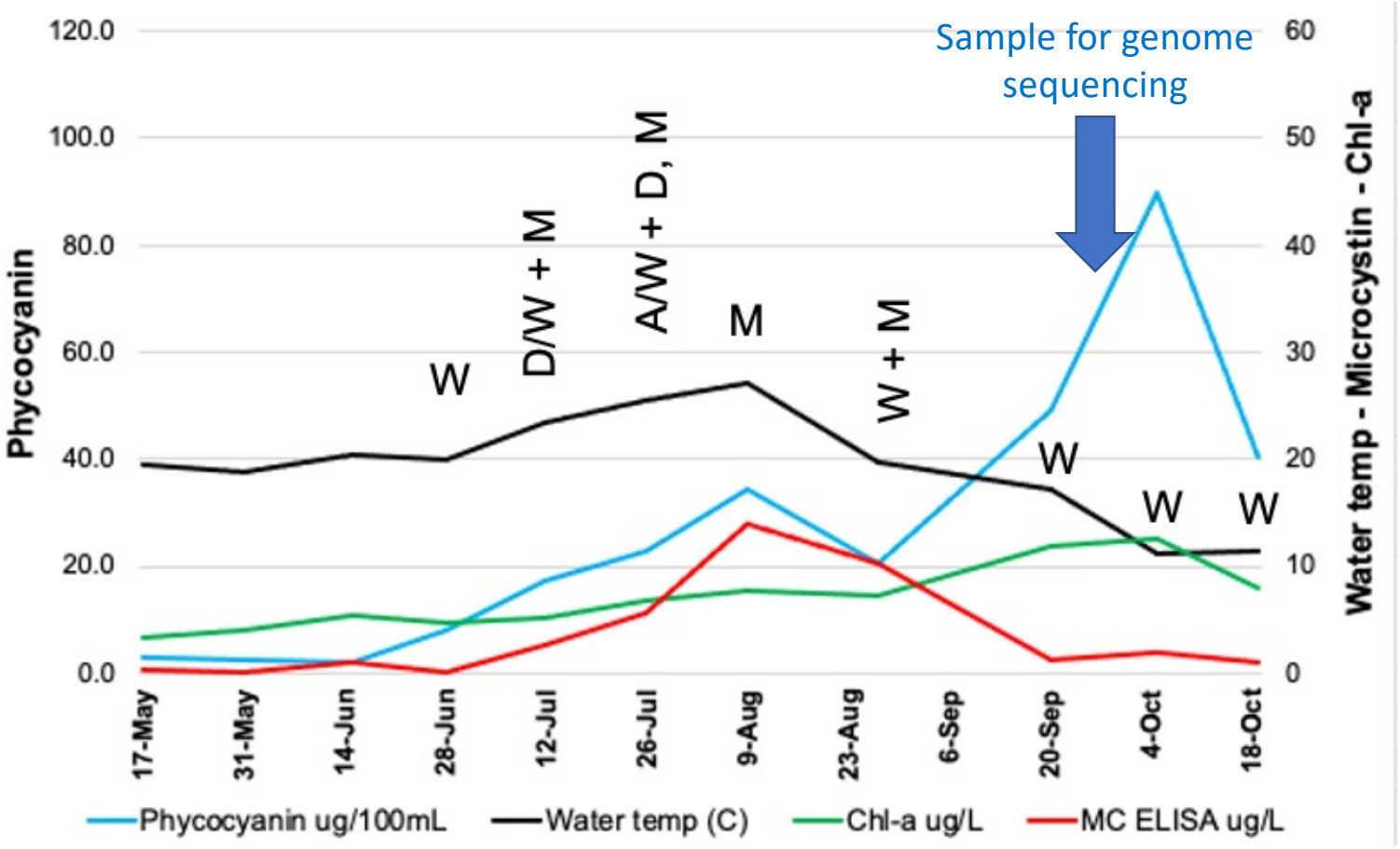
Data source: https://www.nwtoxicalgae.org/Data.aspx

Woronichinia is commonly associated with toxic HABs in WA: is it a toxin producer?



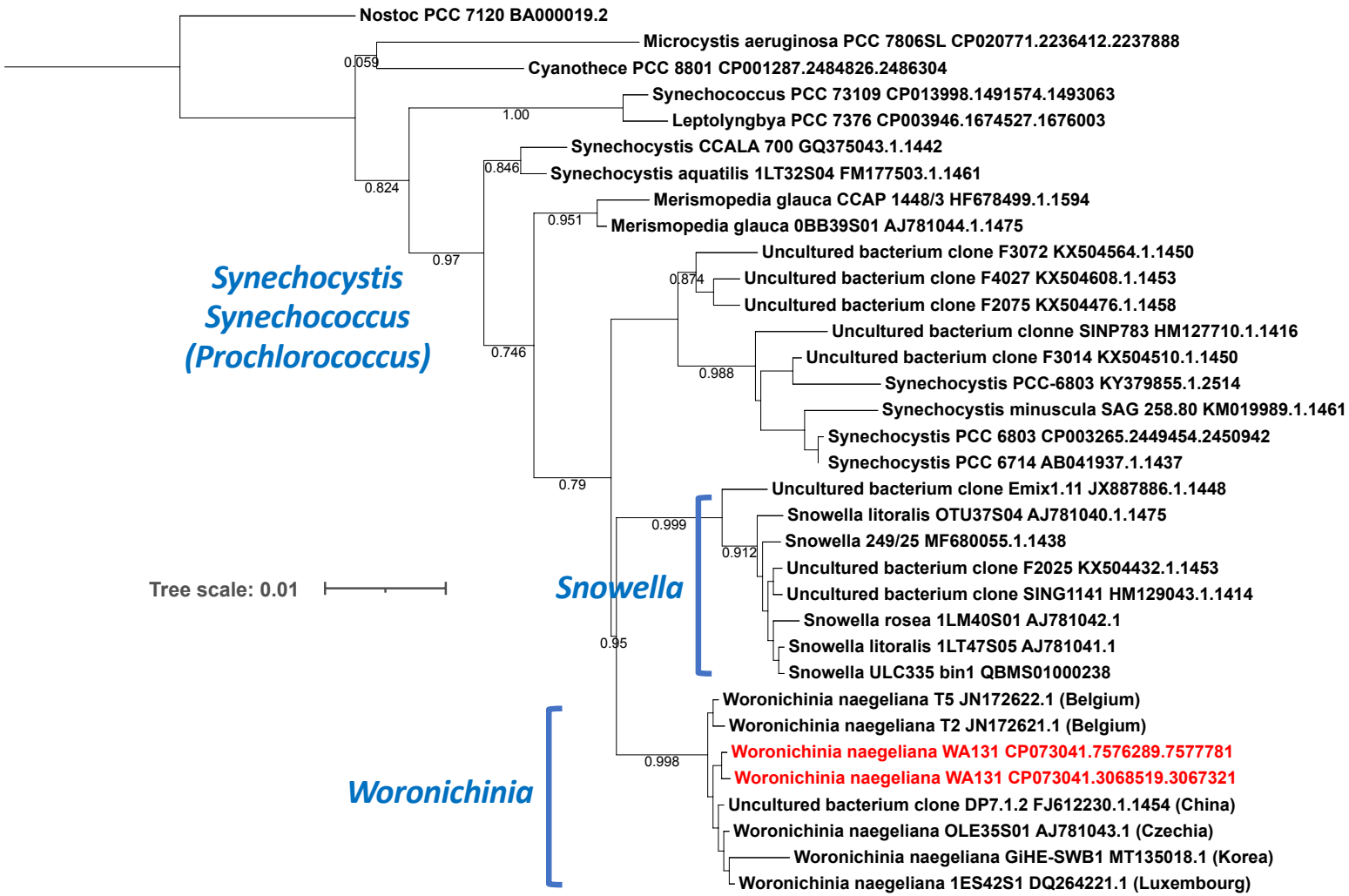
Data source, 2007-2019: https://www.nwtoxicalgae.org/Data.aspx

Woronichinia HABs in Wiser Lake during 2018



***Woronichinia* 16S rRNA sequences from around the world form a cluster**

Closest relative is *Snowella*



Woronichinia WA131 genome compared to genomes of commonly co-occurring HABs

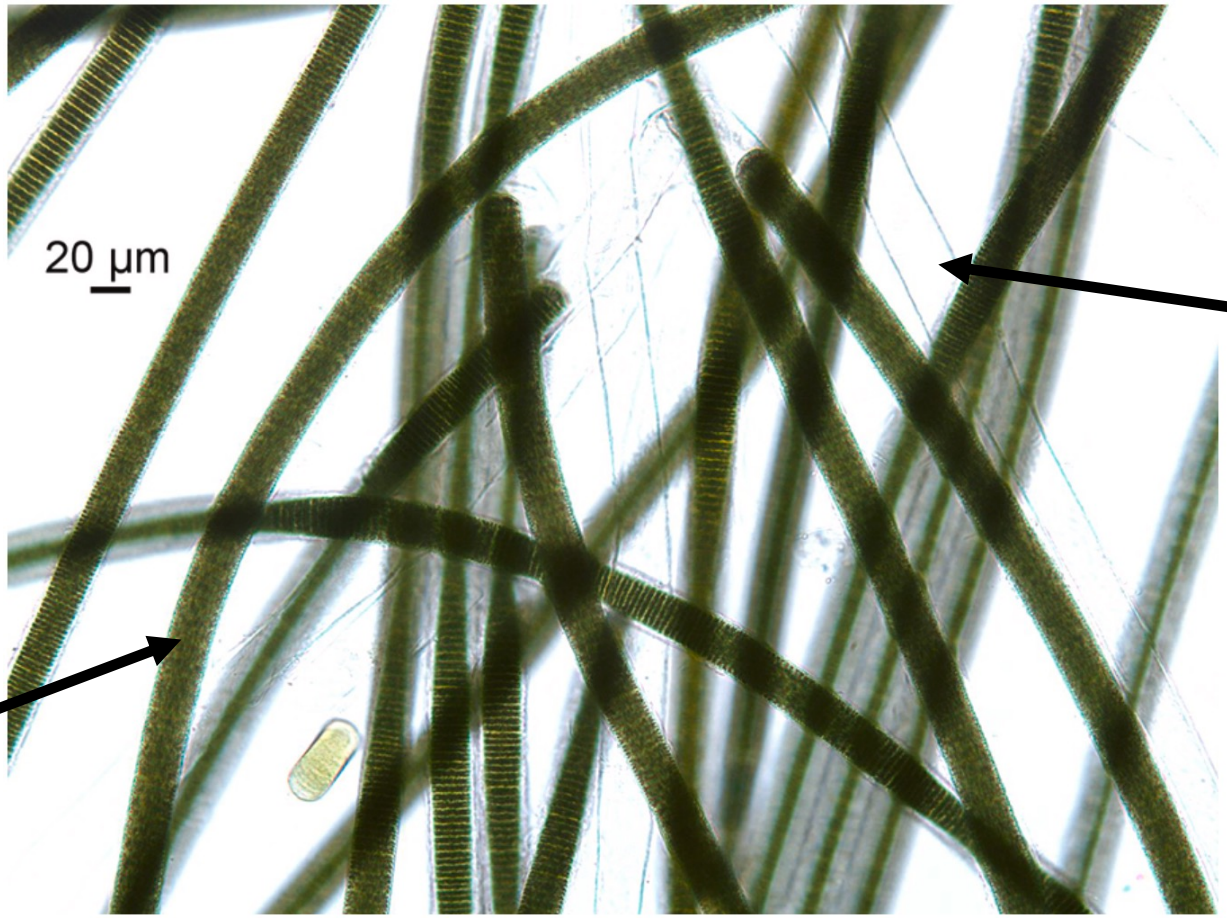
All these cyanoHAB genomes have genes for efficient photosynthesis, nutrient accumulation and buoyancy

W. naegeliana WA131 has no cyanotoxin genes

	Woronichinia naegeliana WA131	**Microcystis aeruginosa PCC_7806SL**	**Anabaena/ Dolichospermum WA102**	**Aphanizomenon flos-aquae DEX188**
Genome size, Mbp	7.87	5.14	5.71	4.54
Total No. CDS (PGAP)	7962	4834	4880	3841
No. KO genes	1940	1863	1854	1658
No. Transposase genes in PGAP	2277	378	133	61
No. IS transposons in ISEScan (complete + partial)	1561 + 480 = 2041	206 + 85 = 291	84 + 33 = 117	39 + 21 = 60
% CDS as transposase	28.6	7.8	2.7	1.6

CDS, protein-coding genes

Limnoraphis from Willow Creek Res., 25 August, 2019



In Pacific NW, this cyanobacterium has often been referred to as *Oscillatoria, Lyngbya, Planktothrix*

Limnoraphis in Washington state

Limnoraphis was observed in 35 lakes during 2019,
Both W and E of the Cascades

Limnoraphis was most abundant in Moses Lake, dominant in Sep 2018 & subdominant in July 2019

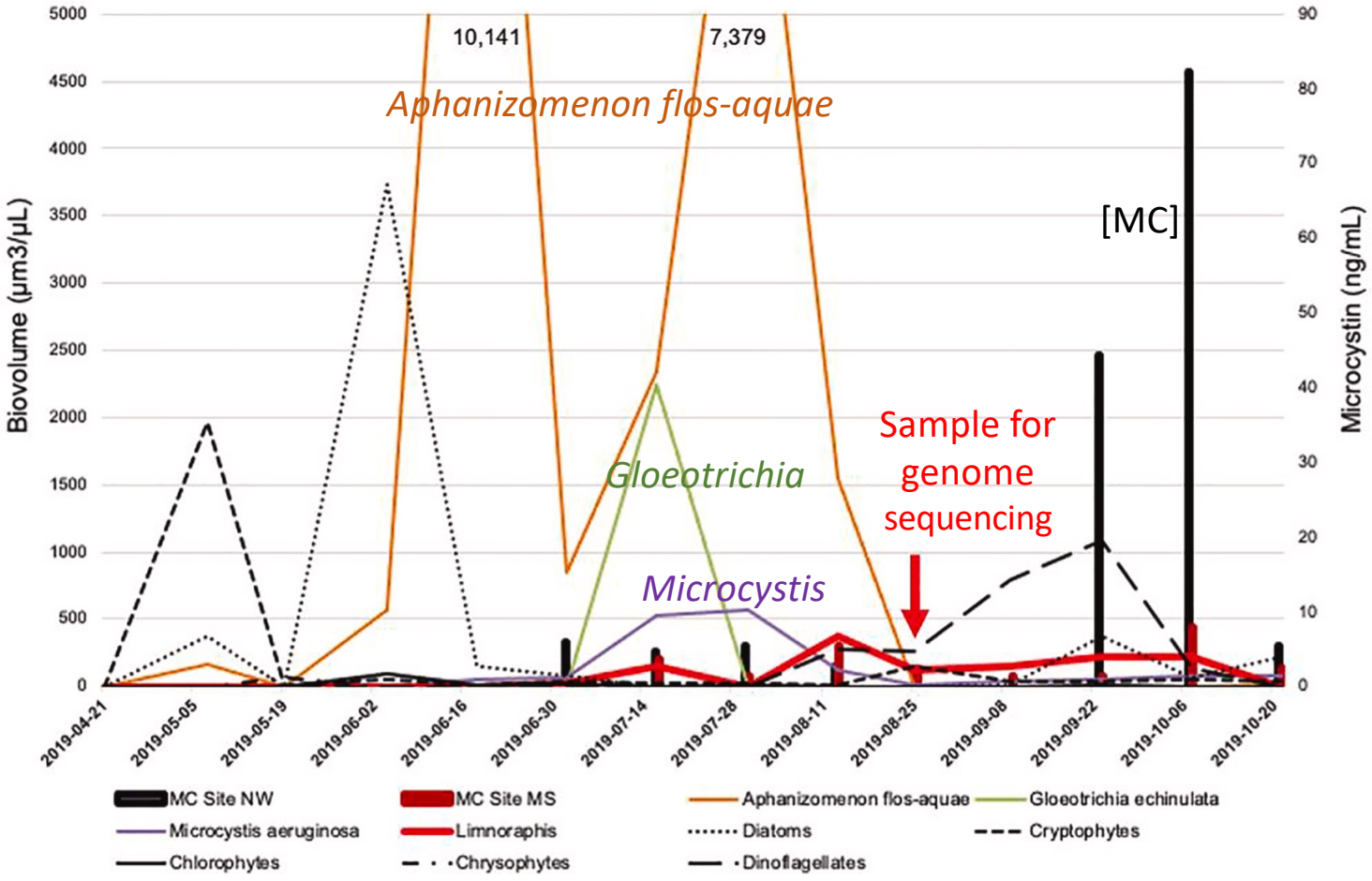
Limnoraphis was often associated with high levels of microcystin (>10 µg/L)

Data from previous years are uncertain, because of previous alternative identifications as *Oscillatoria, Lyngbya, Planktothrix*

Dreher et al., Harmful Algae 118 (2022): 102309

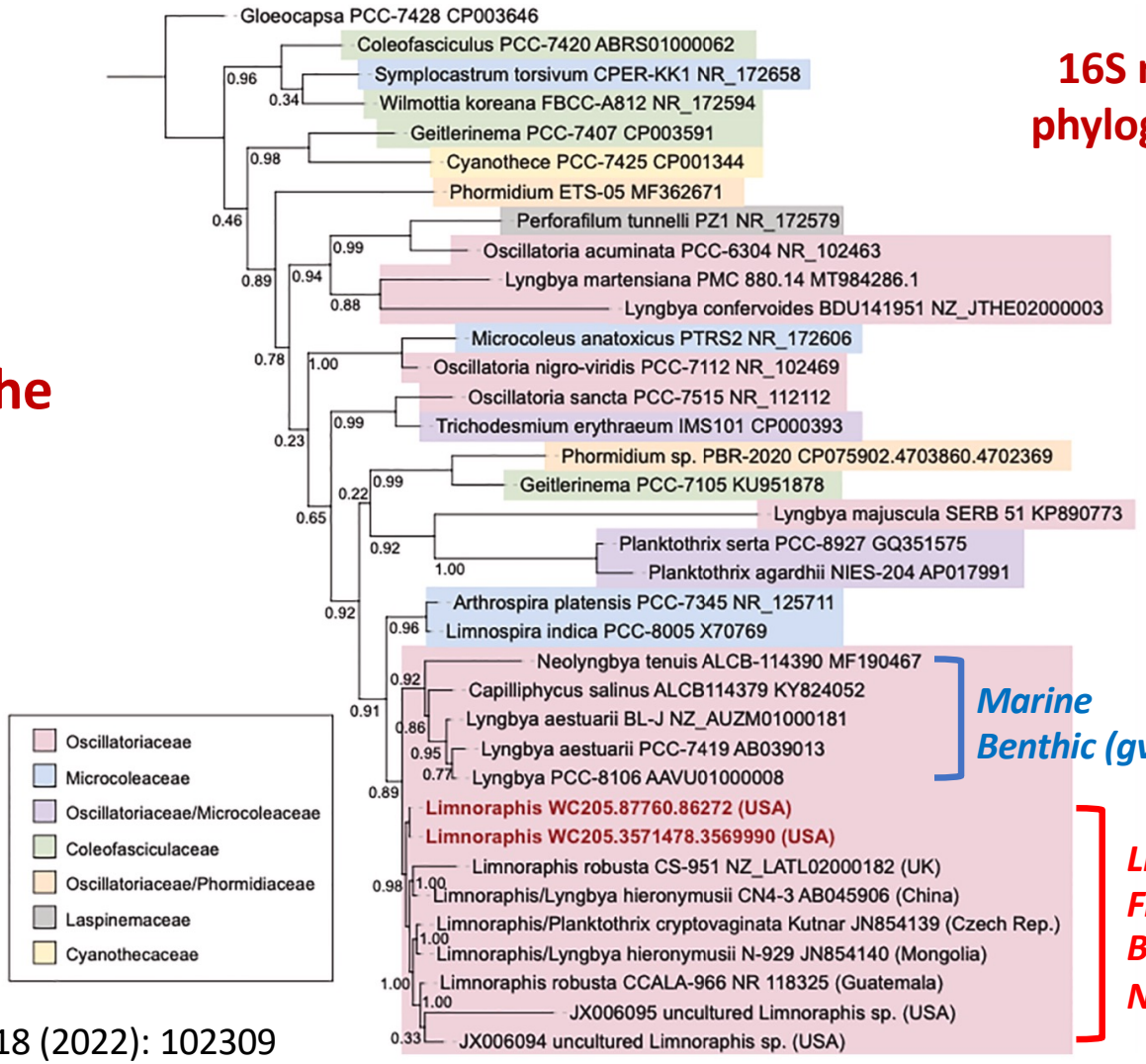
Data source: https://www.nwtoxicalgae.org/Data.aspx

Limnoraphis in Willow Creek Reservoir, 2019



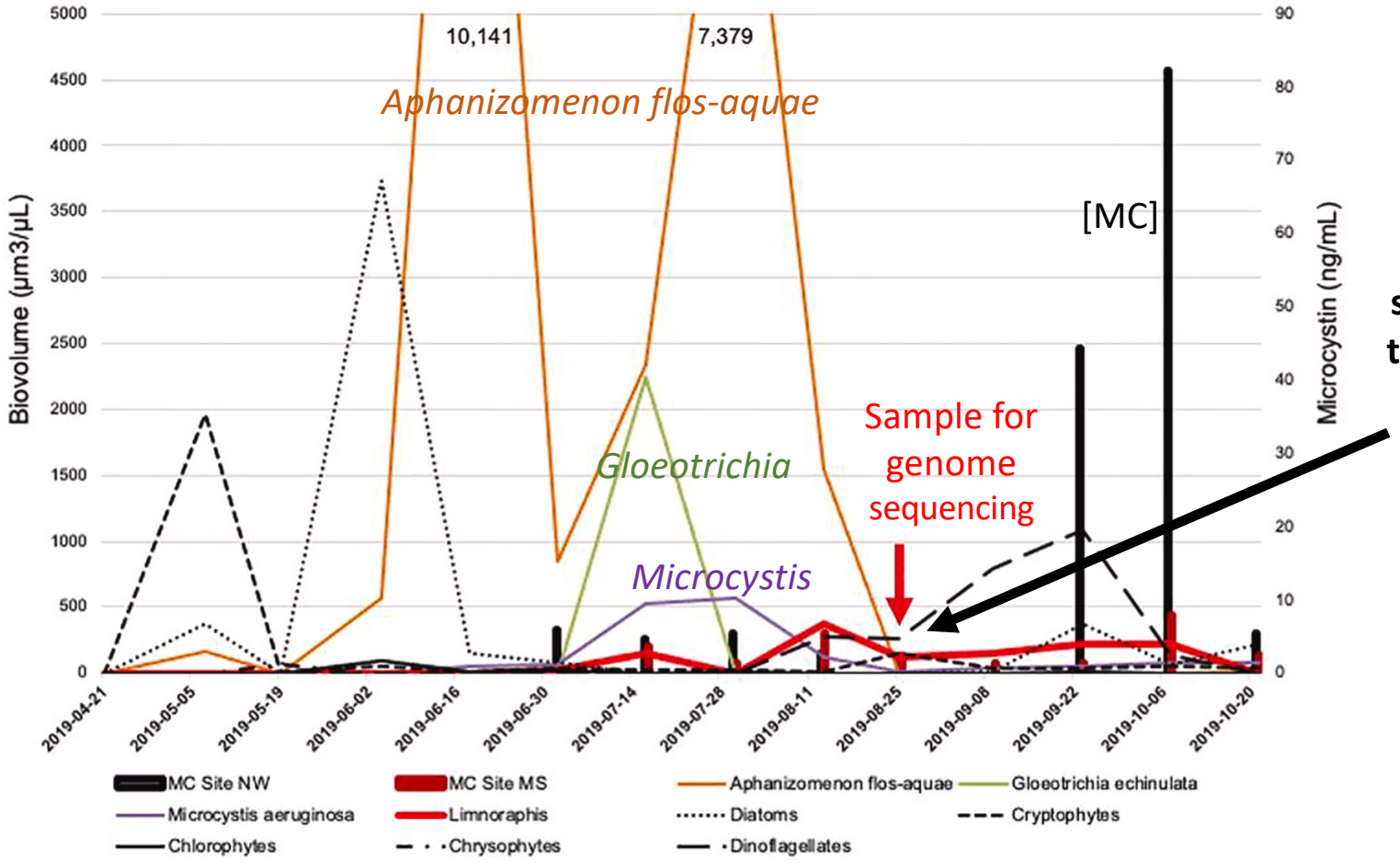
Dreher et al., Harmful Algae 118 (2022): 102309

Limnoraphis relationship in the Oscillatoriales



Dreher et al., Harmful Algae 118 (2022): 102309

Limnoraphis sp. WC205 genome has no cyanotoxin genes



Metagenome sequencing showed the only microcystin biosynthesis genes were from *Microcystis*

Dreher et al., Harmful Algae 118 (2022): 102309

Summary & Conclusions

1) *Woronichinia naegeliana* is widespread in the Pacific NW, common in cyanoHABs together with toxigenic cyanobacteria
2) The *Woronichinia naegeliana* WA131 genome from Wiser Lake, WA, 2018, has no cyanotoxin genes and *Woronichinia* in general is likely non-toxigenic
3) *Snowella* is the closest sister clade to *Woronichinia*

4) *Limnoraphis* is probably more prevalent/abundant east of the Cascades and is also commonly associated with toxigenic cyanobacteria
5) *The Limnoraphis* sp. WC205 genome from Willow Creek Reservoir, OR, 2019, has no cyanotoxin genes and *Limnoraphis* in general is likely non-toxigenic

Acknowledgments

Ryan Mueller
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