Spa Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Spa Lake during 2022 (Figure 1; 10Table 1). Algae were identified to the taxonomic level of species and grouped into broad alga types for analysis.

10*Table 1: Sample sites and dates sampled in 2021 and 2022*

Sample Site (EMS#)	Dates
SPA LAKE @ DEEPEST POINT (E3228511)	2022-06-13 2022-08-31
Total= 2 samples	

Figure 1: Aerial view of Spa Lake

Samples demonstrated seasonal shifts; Chrysophyta blooms in the spring and cyanobacteria blooms in the summer samples. Diatom concentrations were consistently low and spring diatoms demonstrated degradation indicative of lowering silica levels in the late spring (Figure 2).

Summer samples also contained large amorphous clouds of degraded cyanobacteria and bacteria. Degraded cyanobacteria could represent threats to public health as cyanotoxins are usually contaied within the cyanobacterial cells to be released during cell death (EPA, 2022).

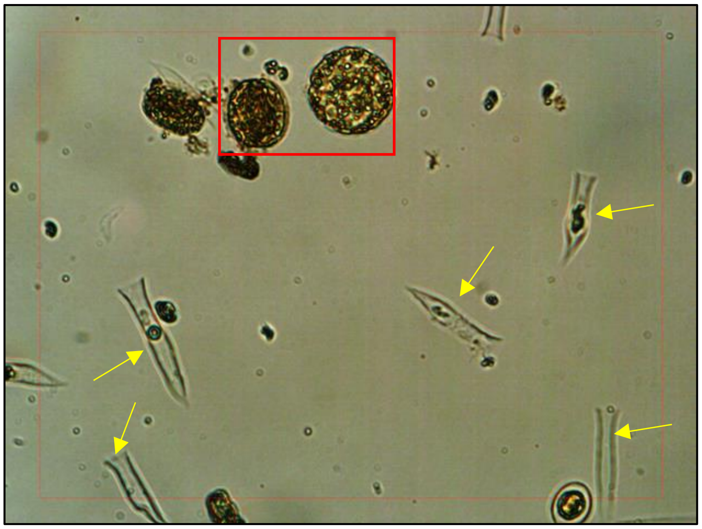

Figure 2: 400x magnification of EMS site E3228511 collected on 2021-05-11 demonstrating degraded Stephanodiscus niagarae diatoms (red box) and a small bloom of Chrysophyte species Dinobryon cylindricum (yellow arrows)

Overview (continued)

Small quantities of the dinoflagellate *Peridinium* were identified in Spa Lake. Despite low numbers, this dinoflagellate represented 7% of biovolumes (Figure 3). This is because of *Peridinium's* large size relative to other algae.

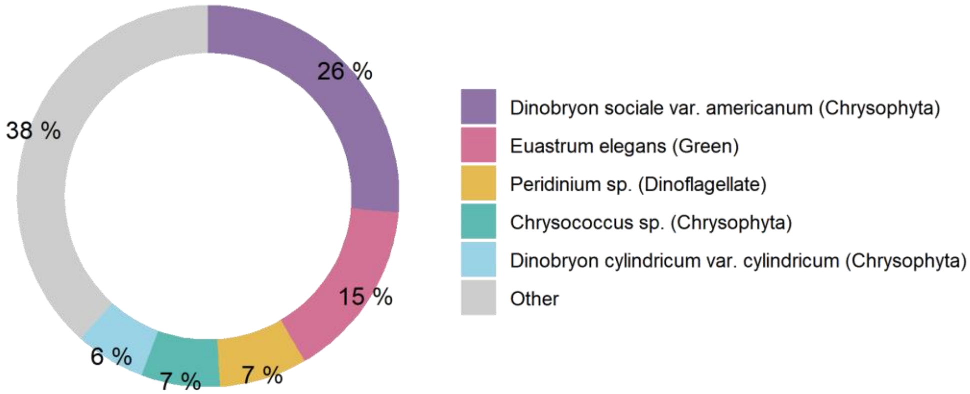

Figure 3: Dominant organisms from Spa Lake (E3228511) as percent of total biovolume

Samples collected in spring 2021 contained elevated densities of Chromalinales (genus *Dinobryon;* (Figure 3; Figure 4)). *Dinobryon* blooms are associated with unpleasant fishy odors, and one species of *Dinobryon* is linked with toxins that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

The spring *Dinobryon* bloom included swarmers (sexual reproductive stages) and stomatocysts (asexual reproductive stages). Stomatocysts are normally produced at 0.05% the rate swarmers are produced (Lee, 2008). When *Dinobryon* populations are in a nitrogen-depleted environment, asexual stomatocysts rise from 0.05% to 4%.

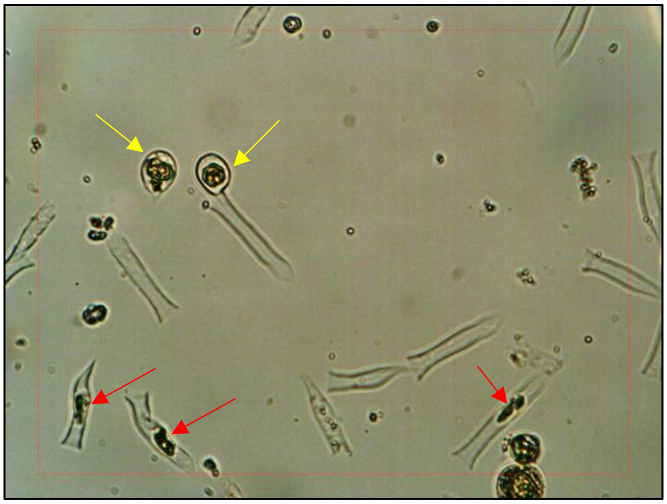

Figure 4: 400x magnification of EMS site E3228511 collected on 2021-05-11 demonstrating a Dinobryon bloom including swarmers (red arrows) and stomatocysts (yellow arrows)

Algae – why should we care?

Algae blooms are becoming more frequent and severe worldwide due to excessive nutrient loading and warming summer lake temperatures. Diatom blooms can cause filter clogging, and odor issues.

Intense cyanobacteria blooms can threaten human safety and aquatic health through their toxicity. Illness related to cyanotoxins can include liver, kidney, and nerve cell damage, cancer, skin and gut irritation, and neurological issues. Cyanotoxins, including microcystins, are now known to accumulate in the food chain (Lance et al., 2014). Fish from lakes with heavy cyanobacteria blooms can have higher toxin concentrations than the lake water (Greer et al. 2021) and consuming them can increase the risk of liver disease (Zhao et al., 2020).

Cyanobacterial Presence

The summer sample contained elevated densities of cyanobacteria. *Aphanocapsa* was the dominant genus counted, but *Merismopedia and Anacystis* were also frequently identified (Figure 5)

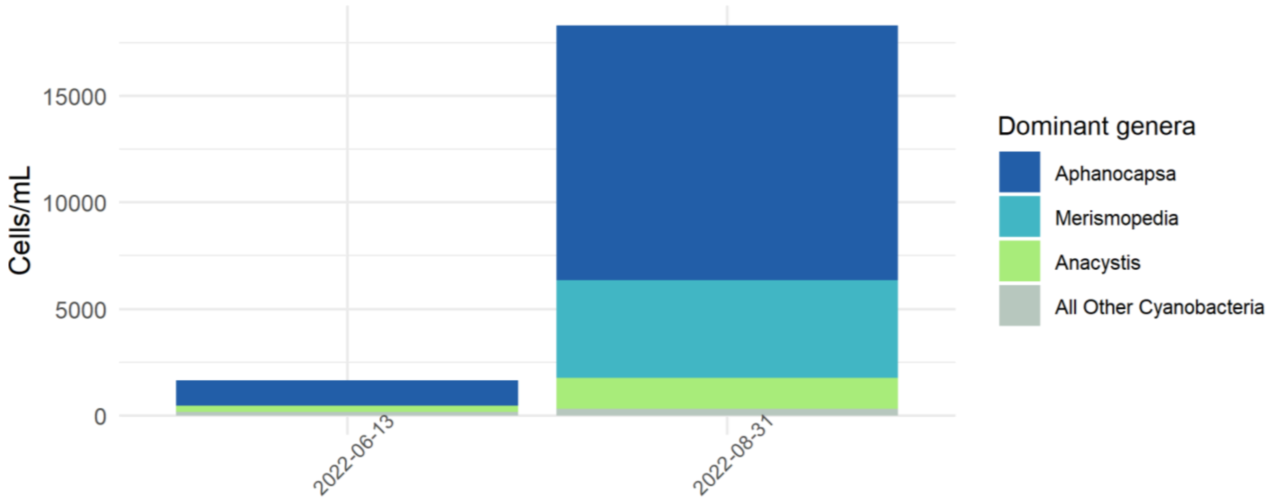

Figure 5: cell abundance for dominant cyanobacteria genera on Spa Lake

Dominant cyanobacteria identified in the summer samples are associated with several cyanotoxins that represent risks to public health (Table 2). Illness related to cyanotoxins can include liver, kidney, and nerve cell damage, cancer, skin and gut irritation, and neurological issues (Lance et al., 2014).

Table 2: Dominant genera of cyanobacteria on Spa Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Aphanocapsa	11976	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Merismopedia	4584	Microcystin MC, BMAA
Anacystis	1062	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT

Note: * = counted in samples

Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Spa Lake can produce cyanotoxins (Table 2).

Spa Lake displayed cyanobacteria levels in the negligible to moderate-risk category, with a mean cyanobacteria abundance of 9,980 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Spa Lake compared to alert levels defined by several authorities including the WHO and EPA.

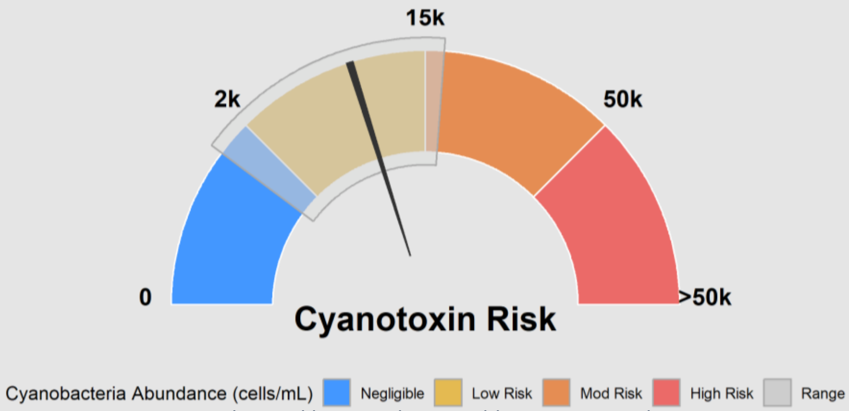

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Spa Lake

Cyanobacteria and micro-flagellates frequently dominate algal communities in total cell count, but because of their small cell size their biovolume is usually low relative to the other types of algae present. This can be seen in Figure 7 where a *Dinobryon* cell dwarfs the adjacent cyanobacteria cell.

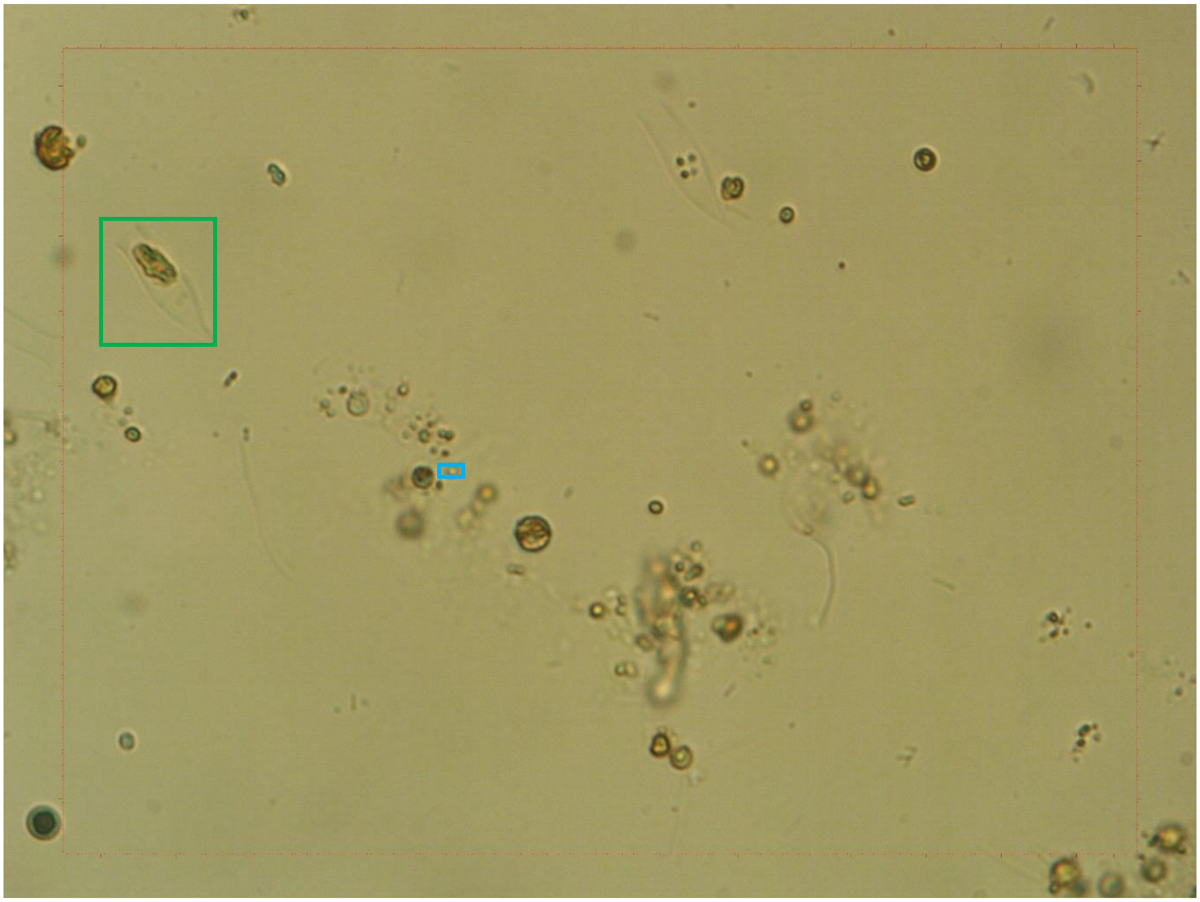

Figure 7: Size comparison of a Ceratium cell (green box) vs a cyanobacteria cell (blue box)

Species Composition

Algae samples were identified to the species level and grouped into broad alga types for analysis. The figures below display the total cell counts for each broad algae group alongside the biovolume represented by each of these groups. The difference between Figure 8 (cell abundance) and Figure 9 (biovolume) illuminates the difference between cell abundance and biovolume.

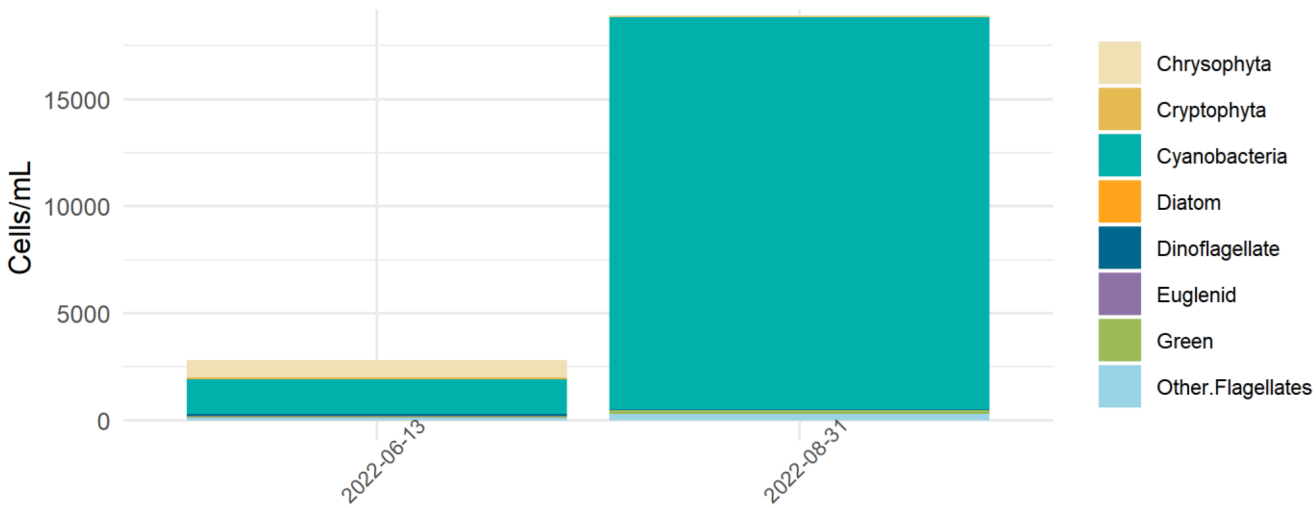

Figure 8: Cell abundance of high-level taxa groups on Spa Lake

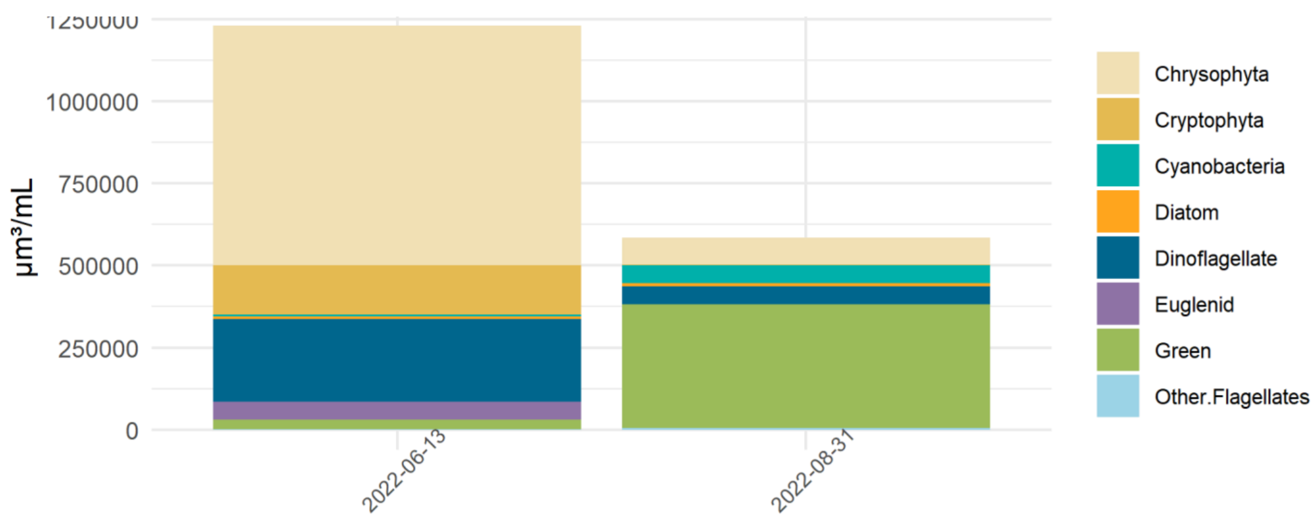

Figure 9: Biovolume of high-level taxa groups on Spa Lake

References

Cantrell, R., & Long, B. (2013). *Dinobryon*. PBWorks. http://ohapbio12.pbworks.com/w/page/51731561/Dinobryon

Conrad, J. (2013). *DINOBRYON, a Golden Alga*. Jim Conrad's Naturalist Newsletter. https://www.backyardnature.net/n/x/dinobryo.htm

EPA. (2022, September). *Learn about Cyanobacteria and Cyanotoxins*. United States Environmental Protection Agency.

Lance, E., Petit, A., Sanchez, W., Paty, C., Gérard, C., & Bormans, M. (2014). Evidence of trophic transfer of microcystins from the gastropod Lymnaea stagnalis to the fish Gasterosteus aculeatus. *Harmful Algae*, *31*, 9–17. https://doi.org/10.1016/J.HAL.2013.09.006

Lee, R. E. (2008). Phycology. In *Phycology* (Fourth, pp. 344–343). Cambridge University Press.

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Appendix

Additional figures and raw data are listed below:

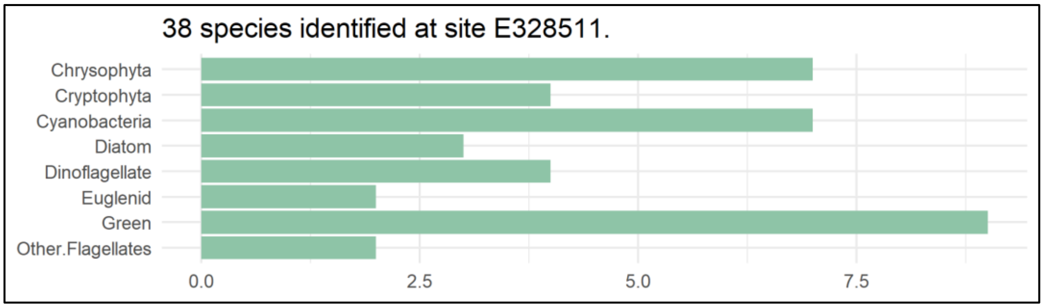

Figure 10: Unique species observed in Spa Lake sorted into higher level taxa

EMS ID: E328511	**Total Abundance (cells/mL):**	**2804**		
Collection Date: 2022-06-13	**Total Biovolume (µm³/mL):**	**1231161**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	30	16207	Chrysophyta	10613
Chrysopyxis sp.	8	2145	Chrysophyta	1831
Ochromonas spp.	8	1596	Chrysophyta	1455
Chrysococcus sp.	357	118533	Chrysophyta	1751
Dinobryon sociale var. americanum	334	467460	Chrysophyta	1515
Dinobryon cylindricum var. cylindricum	68	107880	Chrysophyta	1515
Dinobryon bavaricum	8	17412	Chrysophyta	1515
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Cryptomonas erosa	46	81505	Cryptophyta	10635
Rhodomonas lacustris	8	869	Cryptophyta	10663
Anacystis cyanea	296	446	Cyanobacteria	609
Aphanocapsa cf. delicatissima	1184	3740	Cyanobacteria	625
Aphanothece sp.	152	485	Cyanobacteria	636
Ulnaria acus	8	8335	Diatom	970000
Peridinium sp.	30	135326	Dinoflagellate	10212
Glenodinium sp.	30	59942	Dinoflagellate	10174
Borghiella dodgei	15	53745	Dinoflagellate	
UID dinoflagellate cyst	15	2208	Dinoflagellate	
Trachelomonas cf. pulcherrima	15	49764	Euglenid	9690
Euglena cf. minuta	8	4608	Euglenid	9620
Spondylosium planum	38	17788	Green	8468
Chlamydomonas microscopica	8	5237	Green	5448
Elakatothrix genevensis	8	1434	Green	9412
Desmatractum bipyramidatum	8	6333	Green	5981
picoflagellates	106	356	Other.Flagellates	

Figure 11: Raw data from 2022-06-13 EMS site E3228511

EMS ID: E328511	**Total Abundance (cells/mL):**	**18922**		
Collection Date: 2022-08-31	**Total Biovolume (µm³/mL):**	**585337**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	30	16207	Chrysophyta	10613
Chrysopyxis sp.	8	2145	Chrysophyta	1831
Chrysococcus sp.	8	2656	Chrysophyta	1751
Dinobryon sociale var. americanum	8	11197	Chrysophyta	1515
Dinobryon bavaricum	23	50060	Chrysophyta	1515
Rhodomonas lacustris	15	1629	Cryptophyta	10663
Anacystis cyanea	1062	1599	Cyanobacteria	609
Anacystis clathrata	410	896	Cyanobacteria	609
Aphanocapsa cf. delicatissima	11976	37834	Cyanobacteria	625
Aphanothece sp.	114	364	Cyanobacteria	636
Merismopedia tenuissima	4584	12067	Cyanobacteria	727
Rhabdoderma cf. lineare	30	513	Cyanobacteria	805
Planktolyngbya sp.	152	1889	Cyanobacteria	
Navicula spp.	8	4712	Diatom	3649
Nitzschia sp. small	8	5655	Diatom	5070
Borghiella dodgei	15	53745	Dinoflagellate	
Botryococcus braunii	76	12496	Green	6306
Spondylosium planum	46	21532	Green	8468
Elakatothrix genevensis	15	2689	Green	9412
Euastrum elegans	8	276196	Green	8525
Oocystis borgei	30	19005	Green	5827
Oocystis parva	15	3372	Green	5827
Staurodesmus cuspidatus	8	42726	Green	7182
nanoflagellates	121	3643	Other.Flagellates	
picoflagellates	152	510	Other.Flagellates	

Figure 12: Raw data from 2022-08-31 EMS site E3228511