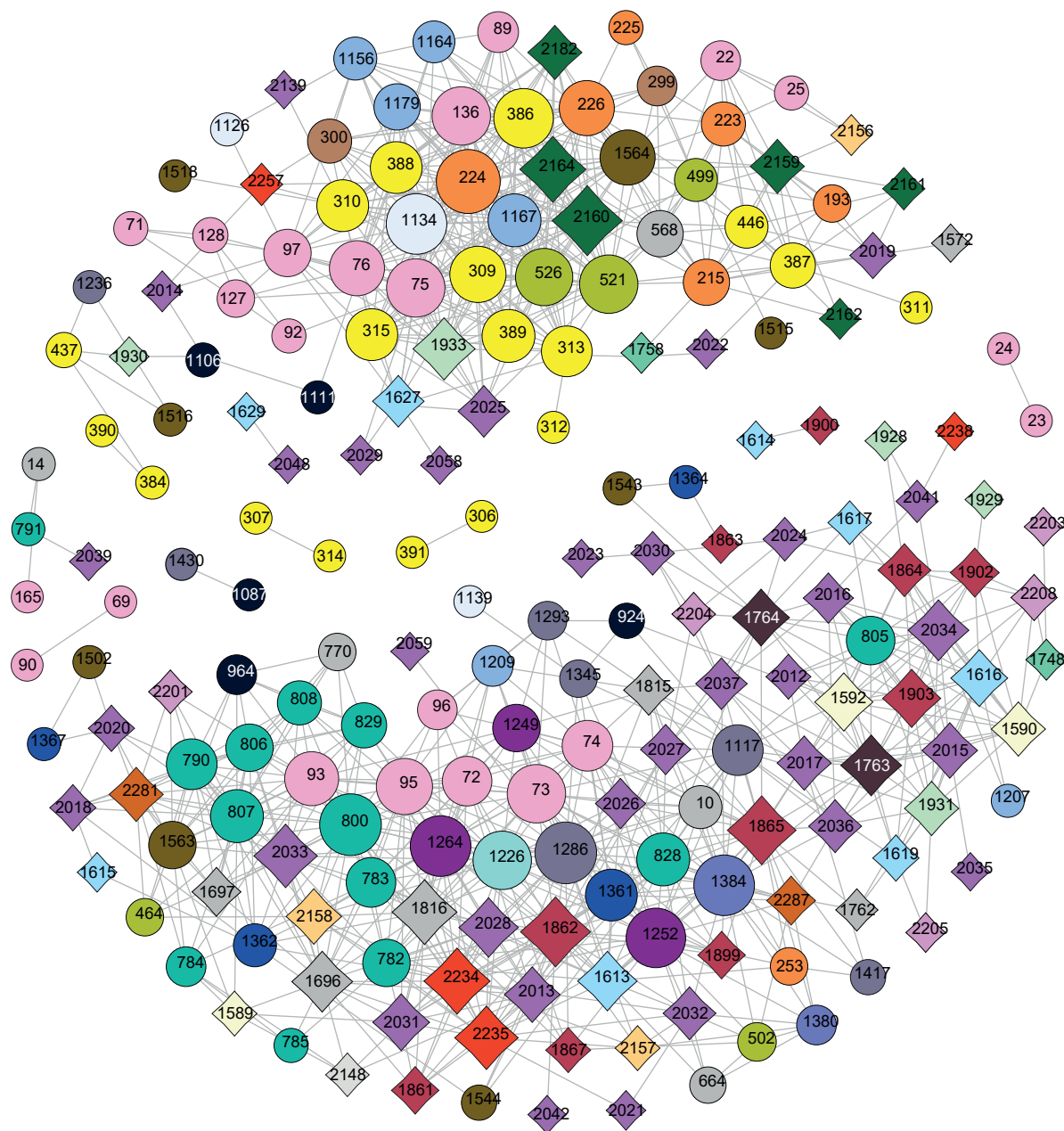


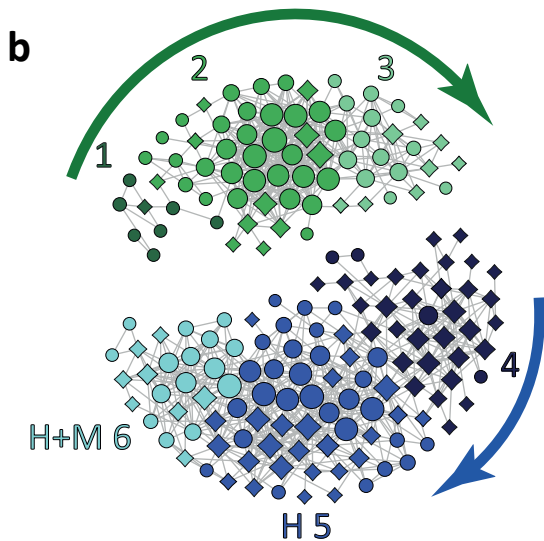
a

Prokaryotes

- Actinobacteriota
- Cytophagales
- Planctomycetota
- Comamonadaceae
- Gallionellaceae
- Methylomonadaceae
- Legionellaceae
- Verrucomicrobiota
- Chitinophagales
- Flavobacteriales
- Sphingobacteriales
- Other Alphaproteobacteria
- Burkholderiaceae
- Nitrosomonadaceae
- Other Gammaproteobacteria
- Others

Protists

- Bacillariophyceae
- Chrysophyceae
- Cryptophyceae
- Chlorophyceae
- Synurophyceae
- Ciliophora
- Telonemia
- Unclassified Alveolata
- Dinophyceae
- Cercozoa
- Bicoecia
- Katablepharida
- Excavata
- Others

b**Additional file 11:**

Network analysis based on the most abundant ASVs from protistan and prokaryotic communities. **a** – network: upper cluster represents the community dominating in the epilimnion, lower cluster represents the community dominating in the hypolimnion. Prokaryotic nodes are displayed as circles, protistan nodes as diamonds. **b** – the main modules detected in the network. The arrows indicate directions of temporal shifts between modules. Differentiation between modules H 5 and H+M 6 is based on spatial parameters as members of module 6 were better resented in the metalimnion communities. Prokaryotic and protistan nodes are organized into modules and listed below, accompanied by heatmaps based on Z scores calculated for each module. Samples are grouped according to water column layers, with the time course depicted from left to right.

Module 1

Phylum	Class	Order	Family	Genus	ID	Epilimnion	Metalimnion	Hypolimnion
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	384			
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	390			
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	437			
Verrucomicrobiota	Verrucomicrobiae	NA	NA	NA	1516			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Methylophilaceae	Methylotenera	1236			
Proteobacteria	Alphaproteobacteria	Sphingomonadales	Sphingomonadaceae	Sphingorhabdus	1106			
Proteobacteria	Alphaproteobacteria	Sphingomonadales	Sphingomonadaceae	Sphingorhabdus	1111			
Archaeplastida	Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadales_X	1930			

Module 2

Phylum	Class	Order	Family	Genus	ID	Epilimnion	Metalimnion	Hypolimnion
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	Candidatus Planktophila	71			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	Candidatus Planktophila	75			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	Candidatus Planktophila	76			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	hgcl clade	89			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	hgcl clade	92			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	hgcl clade	97			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	NA	127			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	NA	128			
Actinobacteriota	Actinobacteria	Micrococcales	Microbacteriaceae	Candidatus Limnoluna	136			
Bacteroidota	Bacteroidia	Chitinophagales	Chitinophagaceae	Sediminibacterium	224			
Bacteroidota	Bacteroidia	Chitinophagales	Chitinophagaceae	Sediminibacterium	225			
Bacteroidota	Bacteroidia	Chitinophagales	Chitinophagaceae	Sediminibacterium	226			
Bacteroidota	Bacteroidia	Cytophagales	Spirosomaceae	Pseudarcicella	299			
Bacteroidota	Bacteroidia	Cytophagales	Spirosomaceae	Pseudarcicella	300			
Bacteroidota	Bacteroidia	Flavobacteriales	Crocinitomicaceae	Fluviicola	309			
Bacteroidota	Bacteroidia	Flavobacteriales	Crocinitomicaceae	Fluviicola	310			
Bacteroidota	Bacteroidia	Flavobacteriales	Crocinitomicaceae	Fluviicola	312			
Bacteroidota	Bacteroidia	Flavobacteriales	Crocinitomicaceae	Fluviicola	313			
Bacteroidota	Bacteroidia	Flavobacteriales	Crocinitomicaceae	Fluviicola	315			
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	386			
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	387			
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	388			
Bacteroidota	Bacteroidia	Flavobacteriales	Flavobacteriaceae	Flavobacterium	389			
Bacteroidota	Bacteroidia	Sphingobacteriales	Sphingobacteriaceae	Pedobacter	521			
Bacteroidota	Bacteroidia	Sphingobacteriales	Sphingobacteriaceae	Solitalea	526			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Burkholderiaceae	Polynucleobacter	1126			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Burkholderiaceae	Polynucleobacter	1134			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Comamonadaceae	Acidovorax	1156			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Comamonadaceae	Limnohabitans	1164			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Comamonadaceae	Limnohabitans	1167			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Comamonadaceae	NA	1179			
Verrucomicrobiota	Verrucomicrobiae	NA	NA	NA	1518			
Verrucomicrobiota	Verrucomicrobiae	Verrucomicrobiales	Verrucomicrobiaceae	NA	1564			
Alveolata	Ciliophora	Spirotrichea	Strombidiida	Pelagostrombidiidae	2014			
Hacrobia	Haptophyta	Prymnesiophyceae	Prymnesiales	Chrysochromulinaceae	2257			
Alveolata	Ciliophora	NA	NA	NA	2139			
Stramenopiles	Ochrophyta	Chrysophyceae	Chrysophyceae_X	NA	1627			
Alveolata	Ciliophora	Oligohymenophora	Peritrichia_2	Sessilida	2058			
Alveolata	Ciliophora	Spirotrichea	Tintinnida	TIN_03	2029			
Alveolata	Ciliophora	Spirotrichea	Hypotrichia	Oxytrichidae	2025			
Hacrobia	Cryptophyta	Cryptophyceae	Cryptomonadales	Cryptomonadales_X	2164			
Hacrobia	Cryptophyta	NA	NA	NA	2182			
Archaeplastida	Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadales_X	1933			
Hacrobia	Cryptophyta	Cryptophyceae	Cryptomonadales	Cryptomonadales_X	2160			

Z score

Max

50%

0

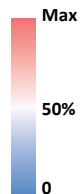
Prokaryotic
ASVs

Protistan
ASVs

Module 3

Phylum	Class	Order	Family	Genus	ID	Epilimnion	Metalimnion	Hypolimnion
Chloroflexi	SL56 marine group	NA	NA	NA	568			
Bacteroidota	Bacteroidia	Chitinophagales	Chitinophagaceae	NA	215			
Verrucomicrobiota	Verrucomicrobiae	NA	NA	NA	1515			
Bacteroidota	Bacteroidia	Flavobacteriales	Crocinitomicaceae	Fluviicola	311			
Bacteroidota	Bacteroidia	Flavobacteriales	NS9 marine group	NA	446			
Bacteroidota	Bacteroidia	Chitinophagales	Chitinophagaceae	Edaphobaculum	193			
Bacteroidota	Bacteroidia	Sphingobacteriales	NS11-12 marine group	NA	499			
Bacteroidota	Bacteroidia	Chitinophagales	Chitinophagaceae	Sediminibacterium	223			
Actinobacteriota	Acidimicrobiia	Microtrichales	Ilumatobacteraceae	CL500-29 marine group	22			
Actinobacteriota	Acidimicrobiia	Microtrichales	Ilumatobacteraceae	CL500-29 marine group	25			
Alveolata	Apicomplexa	Cocciidiomorpha	Adeleida	NA	1572			
Alveolata	Ciliophora	Spirotrichea	Strombidiida_A	Strombidiida_A_X	2022			
Hacrobia	Katablepharidophyta	Katablepharidaceae	Katablepharidales	Katablepharidales_X	2156			
Hacrobia	Cryptophyta	Cryptophyceae	Cryptomonadales	Cryptomonadales_X	2159			
Hacrobia	Cryptophyta	Cryptophyceae	Cryptomonadales	Cryptomonadales_X	2161			
Hacrobia	Cryptophyta	Cryptophyceae	Cryptomonadales	Cryptomonadales_X	2162			
Stramenopiles	Ochrophyta	Synurophyceae	Synurales	Synurales_X	1758			
Alveolata	Ciliophora	Spirotrichea	Choreotrichida	Strobiliidiidae_D	2019			

Z score



Prokaryotic ASVs



Module 4

Phylum	Class	Order	Family	Genus	ID	Epilimnion	Metalimnion	Hypolimnion
Planctomycetota	Planctomycetes	Pirellulales	Pirellulaceae	NA	805			
Verrucomicrobiota	Verrucomicrobiae	Pedosphaerales	Pedosphaeraceae	NA	1543			
Proteobacteria	Gammaproteobacteria	Legionellales	Legionellaceae	Legionella	1364			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Comamonadaceae	Polaromonas	1207			
Stramenopiles	Ochrophyta	Bacillariophyta	Bacillariophyta_X	Polar-centric-Mediophyceae	1590			
Stramenopiles	Ochrophyta	Bacillariophyta	Bacillariophyta_X	Polar-centric-Mediophyceae	1592			
Stramenopiles	Ochrophyta	Chrysophyceae	Chrysophyceae_X	Chrysophyceae_Clade-C	1616			
Stramenopiles	Ochrophyta	Chrysophyceae	Chrysophyceae_X	NA	1617			
Stramenopiles	Ochrophyta	Chrysophyceae	Chrysophyceae_X	Chrysophyceae_Clade-E	1619			
Stramenopiles	Ochrophyta	Synurophyceae	Synurales	Synurales_X	1748			
Stramenopiles	Opalozoa	Bicoecea	Bicoceales	Bicoecaceae	1763			
Stramenopiles	Opalozoa	Bicoecea	Bicoceales	Bicoecaceae	1764			
Rhizaria	Cercozoa	NA	NA	NA	1863			
Rhizaria	Cercozoa	Filosa-Thecofilosea	Ebriida	Botuliformidae	1864			
Rhizaria	Cercozoa	NA	NA	NA	1902			
Rhizaria	Cercozoa	NA	NA	NA	1903			
Archaeplastida	Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadales_X	1928			
Archaeplastida	Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadales_X	1929			
Archaeplastida	Chlorophyta	Chlorophyceae	Chlamydomonadales	Chlamydomonadales_X	1931			
Alveolata	Ciliophora	Oligohymenophore:	Scuticociliatia_2	Histiobalantiidae	2012			
Alveolata	Ciliophora	Spirotrichea	Tintinnida	Tintinnidiidae	2015			
Alveolata	Ciliophora	Oligohymenophore:	Peritrichia_2	Sessilida	2016			
Alveolata	Ciliophora	Spirotrichea	Hypotrichia	NA	2017			
Alveolata	Ciliophora	Litostomatea	Litostomatea_X	Litostomatea_XX	2023			
Alveolata	Ciliophora	Colpodea	Colpodea_X	NA	2024			
Alveolata	Ciliophora	NA	NA	NA	2030			
Alveolata	Ciliophora	Oligohymenophore:	Peritrichia_2	Sessilida	2034			
Alveolata	Ciliophora	Spirotrichea	Tintinnida	Tintinnidiidae	2035			
Alveolata	Ciliophora	Litostomatea	NA	NA	2036			
Alveolata	Ciliophora	Phyllopharyngea	Suctorina	Tokophryidae	2037			
Alveolata	Ciliophora	Oligohymenophore:	Peritrichia_2	Sessilida	2041			
Alveolata	Dinoflagellata	Dinophyceae	Gymnodiniales	Gymnodiniaceae	2203			
Alveolata	Dinoflagellata	Dinophyceae	Prorocentrales	Prorocentraceae	2204			
Alveolata	Dinoflagellata	Dinophyceae	Prorocentrales	Prorocentraceae	2205			
Alveolata	Dinoflagellata	Dinophyceae	NA	NA	2208			
Alveolata	NA	NA	NA	NA	2238			

Module 5

Phylum	Class	Order	Family	Genus	ID	Epilimnion	Metalimnion	Hypolimnion
Acidobacteriota	Vicinamibacteria	Vicinamibacteriales	NA	NA	10			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	Candidatus Planktophila	72			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	Candidatus Planktophila	73			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	Candidatus Planktophila	74			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	hgcl clade	95			
Actinobacteriota	Actinobacteria	Frankiales	Sporichthyaceae	hgcl clade	96			
Bacteroidota	Bacteroidia	Chitinophagales	NA	NA	253			
Bacteroidota	Bacteroidia	Sphingobacteriales	NS11-12 marine group	NA	502			
Myxococcota	Polyangia	mle1-27	NA	NA	664			
Planctomycetota	Phycisphaerae	Phycisphaerales	Phycisphaeraceae	CL500-3	782			
Planctomycetota	Phycisphaerae	Phycisphaerales	Phycisphaeraceae	CL500-3	783			
Planctomycetota	Phycisphaerae	Phycisphaerales	Phycisphaeraceae	CL500-3	785			
Planctomycetota	Planctomycetes	Pirellulales	Pirellulaceae	NA	808			
Planctomycetota	Planctomycetes	Planctomycetales	Rubinisphaeraceae	SH-PL14	828			
Proteobacteria	Alphaproteobacteria	Rhizobiales	Beijerinckiaceae	alpha cluster	924			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Alcaligenaceae	GKS98 freshwater group	1117			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Burkholderiaceae	Polynucleobacter	1139			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Comamonadaceae	Rhizobacter	1209			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Gallionellaceae	Candidatus Nitrotoga	1226			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Nitrosomonadaceae	GOUTA6	1249			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Nitrosomonadaceae	NA	1252			
Proteobacteria	Gammaproteobacteria	Burkholderiales	Nitrosomonadaceae	Nitrosospira	1264			
Proteobacteria	Gammaproteobacteria	Burkholderiales	SC-I-84	NA	1286			
Proteobacteria	Gammaproteobacteria	Burkholderiales	TRA3-20	NA	1293			
Proteobacteria	Gammaproteobacteria	Diplorickettsiales	Diplorickettsiaceae	Rickettsiella	1345			
Proteobacteria	Gammaproteobacteria	Legionellales	Legionellaceae	Legionella	1361			
Proteobacteria	Gammaproteobacteria	Methylococcales	Methylomonadaceae	Methylobacter	1380			
Proteobacteria	Gammaproteobacteria	Methylococcales	Methylomonadaceae	Methylobacter	1384			
Proteobacteria	Gammaproteobacteria	Pseudomonadales	Pseudohongiellaceae	Blyi10	1417			
Verrucomicrobiota	Verrucomicrobiae	Pedosphaerales	Pedosphaeraceae	NA	1544			
Verrucomicrobiota	Verrucomicrobiae	Verrucomicrobiales	Verrucomicrobiaceae	NA	1563			
Stramenopiles	Ochrophyta	Chrysophyceae	Chrysophyceae_X	NA	1613			
Stramenopiles	Ochrophyta	NA	NA	NA	1696			
Stramenopiles	Pseudofungi	MAST-2	MAST-2C	MAST-2C_X	1762			
Stramenopiles	NA	NA	NA	NA	1815			
Stramenopiles	NA	NA	NA	NA	1816			
Rhizaria	Cercozoa	Filosa-Imbricatea	Filosa-Imbricatea_X	Novel-clade-2	1861			
Rhizaria	Cercozoa	Filosa-Imbricatea	Thaumatomonadida	Peregriniidae	1862			
Rhizaria	Cercozoa	Filosa-Thecofilosea	Cryomonadida	Cryothecomonas-lineage	1865			
Rhizaria	Cercozoa	Filosa-Thecofilosea	Cryomonadida	NA	1867			
Rhizaria	Cercozoa	NA	NA	NA	1899			
Alveolata	Ciliophora	NA	NA	NA	2013			
Alveolata	Ciliophora	Oligohymenophorea	Hymenostomatia	Ophryoglenida	2021			
Alveolata	Ciliophora	Spirotrichea	Choreotrichida	NA	2026			
Alveolata	Ciliophora	NA	NA	NA	2027			
Alveolata	Ciliophora	NA	NA	NA	2028			
Alveolata	Ciliophora	NA	NA	NA	2031			
Alveolata	Ciliophora	NA	NA	NA	2032			
Alveolata	Ciliophora	Litostomatea	NA	NA	2042			
Alveolata	Ciliophora	Ciliophora_X	Ciliophora_XX	Ciliophora_XXX	2059			
Hacrobia	Telonemia	Telonemia_X	Telonemia_XX	Telonemia-Group-2	2148			
Hacrobia	Katablepharidophyta	Katablepharidaceae	Katablepharidales	Katablepharidales_X	2157			
Hacrobia	Katablepharidophyta	Katablepharidaceae	Katablepharidales	Katablepharidales_X	2158			
Alveolata	NA	NA	NA	NA	2234			
Alveolata	NA	NA	NA	NA	2235			
Excavata	Discoba	Kinetoplastea	Eubodonida	Bodonidae	2287			

Z score

Max

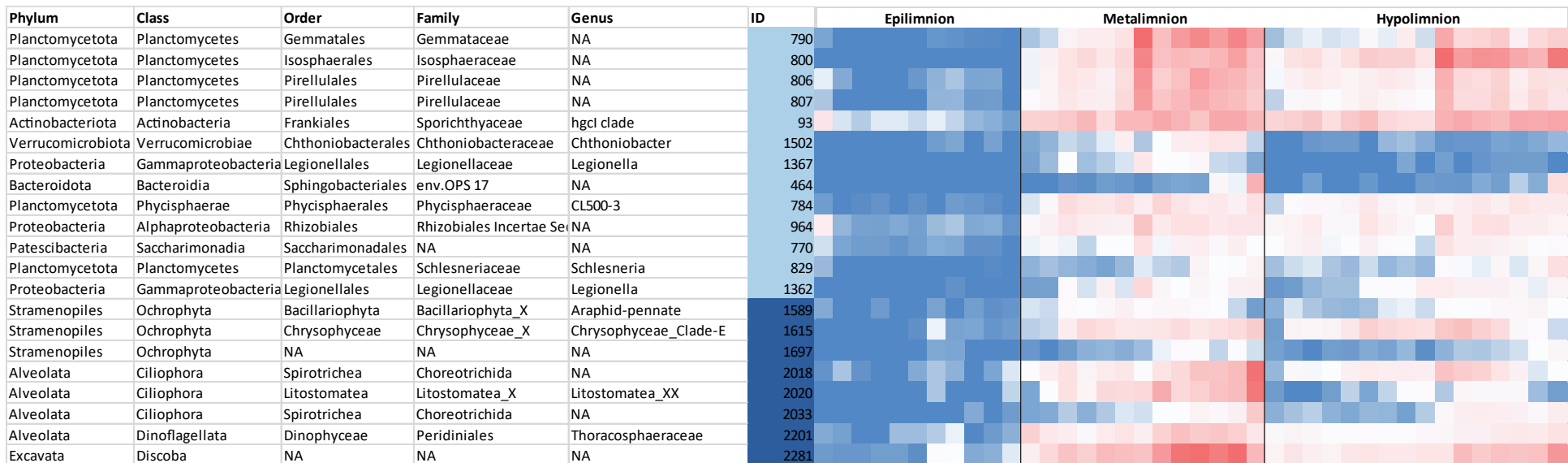
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Prokaryotic
ASVs

Protistan
ASVs

Module 6



Diverse small modules

