PHYTOPLANKTON DIVERSITY IN THE CONGO RIVER

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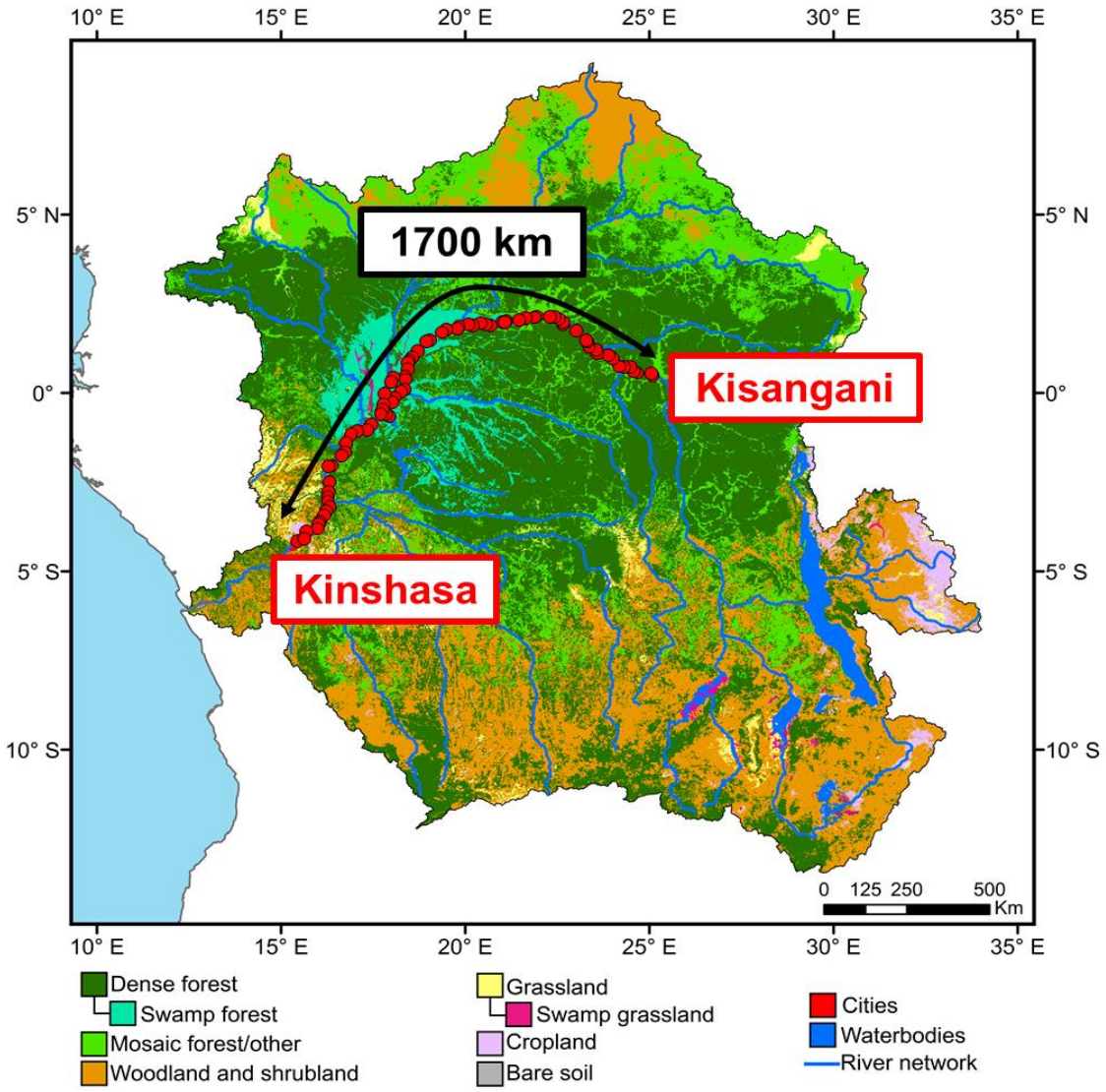
Sampling the R. Congo



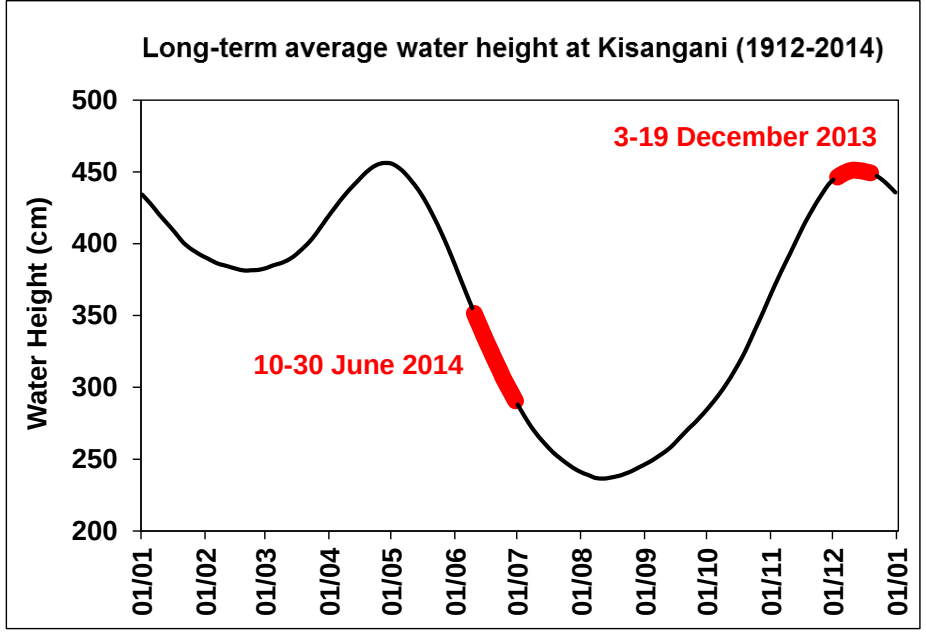
The TRANSCONGO project investigates the biogeochemistry of carbon (allochthonous vs. autochthonous sources) in the R. Congo.

R. Congo is the 2d largest river in the World in terms of discharge (1457 $km^3\ y^{-1}$) and drainage basin (3.75 million km^2)

It is a near-pristine system, compared to many other large rivers

Sampling (main rivers and large tributaries) was carried out on a 1700 km stretch in two contrasting flow conditions

R. Congo mainstem: white waters
Tributaries: mostly black waters



164 stations
29 variables

> 23,000 continuous measurements
pCO_2, cond, temp, pH, O_2, TSM, cDOM

The phytoplankton study

- HPLC determination of chlorophyll a and marker pigments: estimate of total biomass and contribution of main phyla/classes using CHEMTAX

- Microscopy on plankton net samples (28 µm)

Here we report the results on taxonomic diversity and its drivers

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Phytoplankton dynamics in the Congo River

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Divergent biophysical controls of aquatic CO_2 and CH_4 in the World's two largest rivers

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Shift in the chemical composition of dissolved organic matter in the Congo River network

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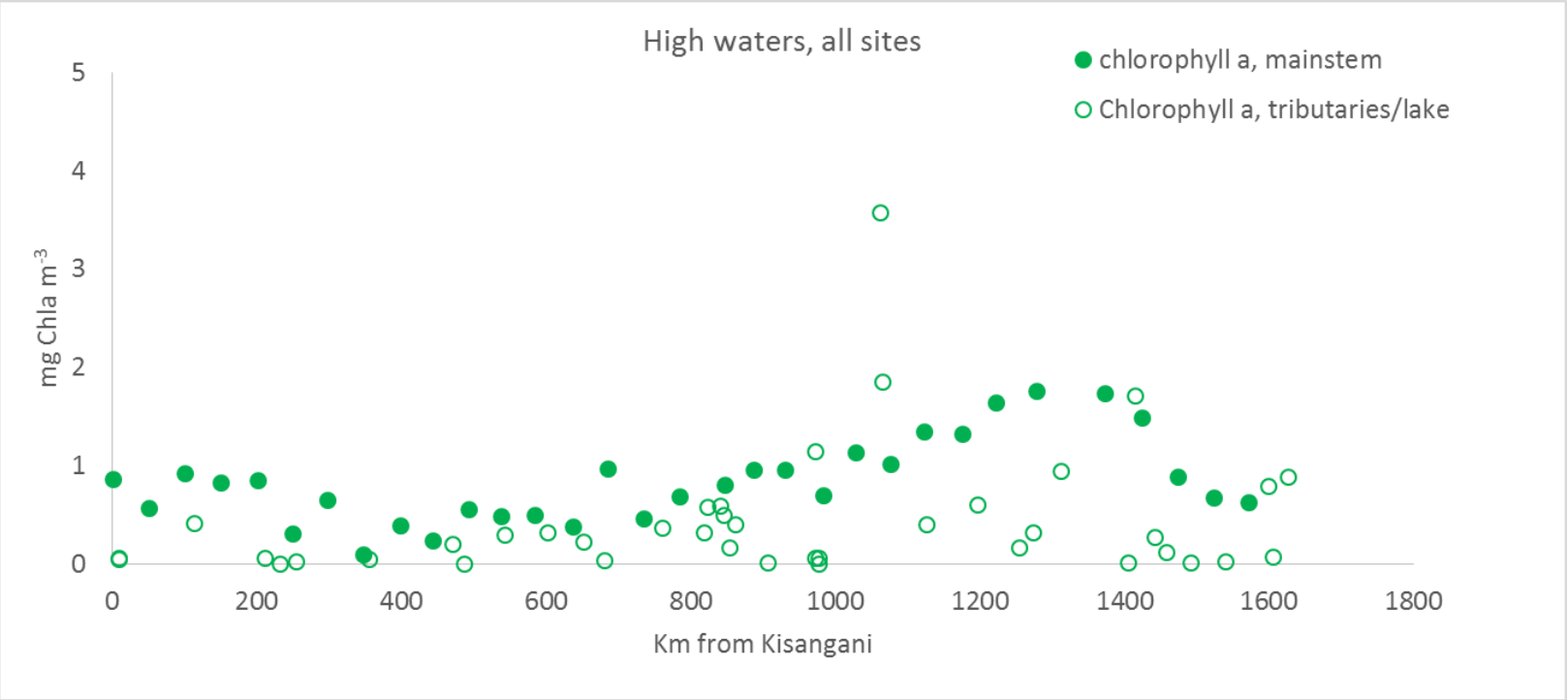
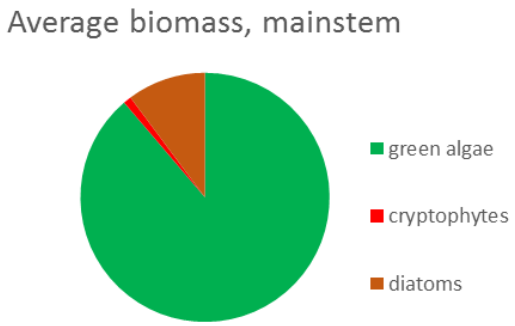
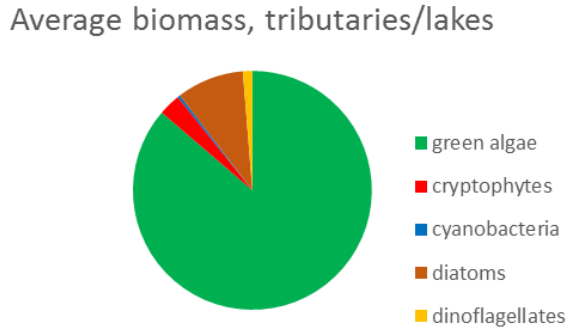
Outline of the presentation

1. Longitudinal variation of chlorophyll a concentration and general contribution of phytoplankton groups
2. Multivariate analyses (PCA and RDA) for identifying the main drivers of phytoplankton composition (at group/class level)
3. Changes of taxonomic diversity (at species level)
4. Drivers of taxonomic diversity ?

High waters (December 2013)

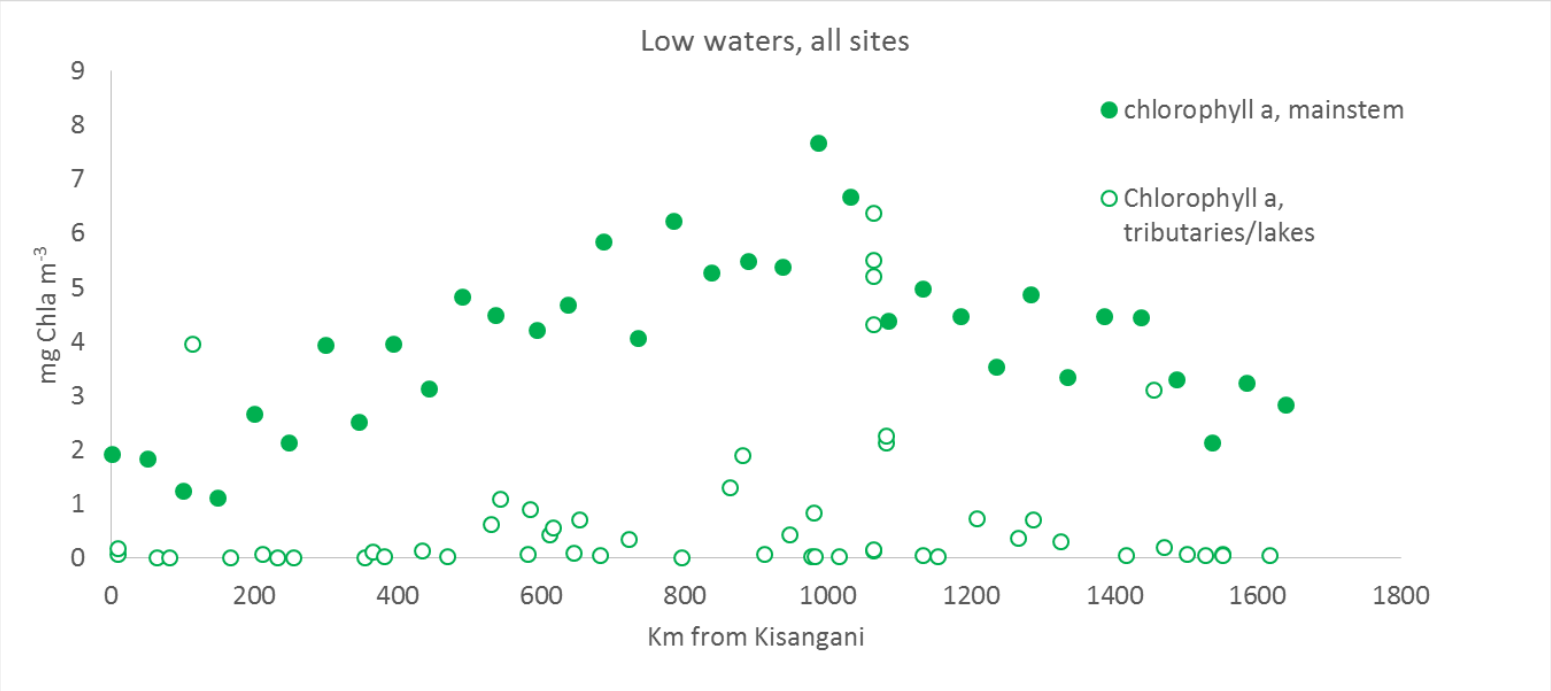


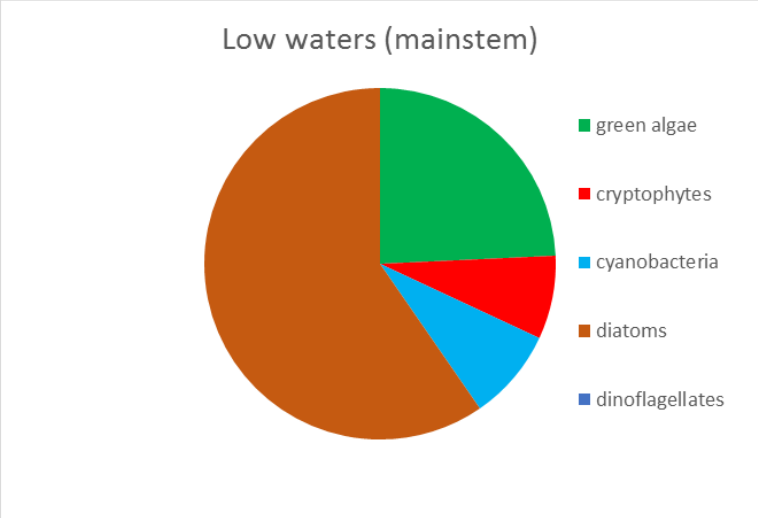


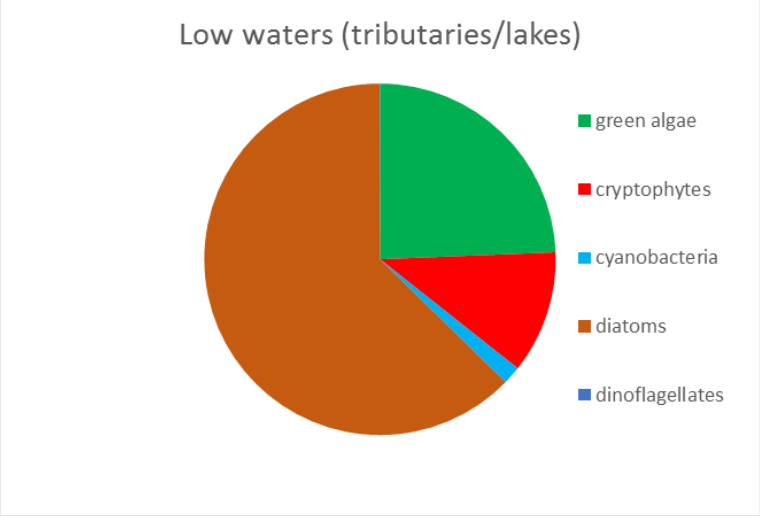


- Low chlorophyll a in the main river (< 2 mg m^{-3})
- Slight longitudinal increase, with maximum at 1400 km
- Dominance of green algae, both in the main river, tributaries and lakes

Falling waters (June 2014)



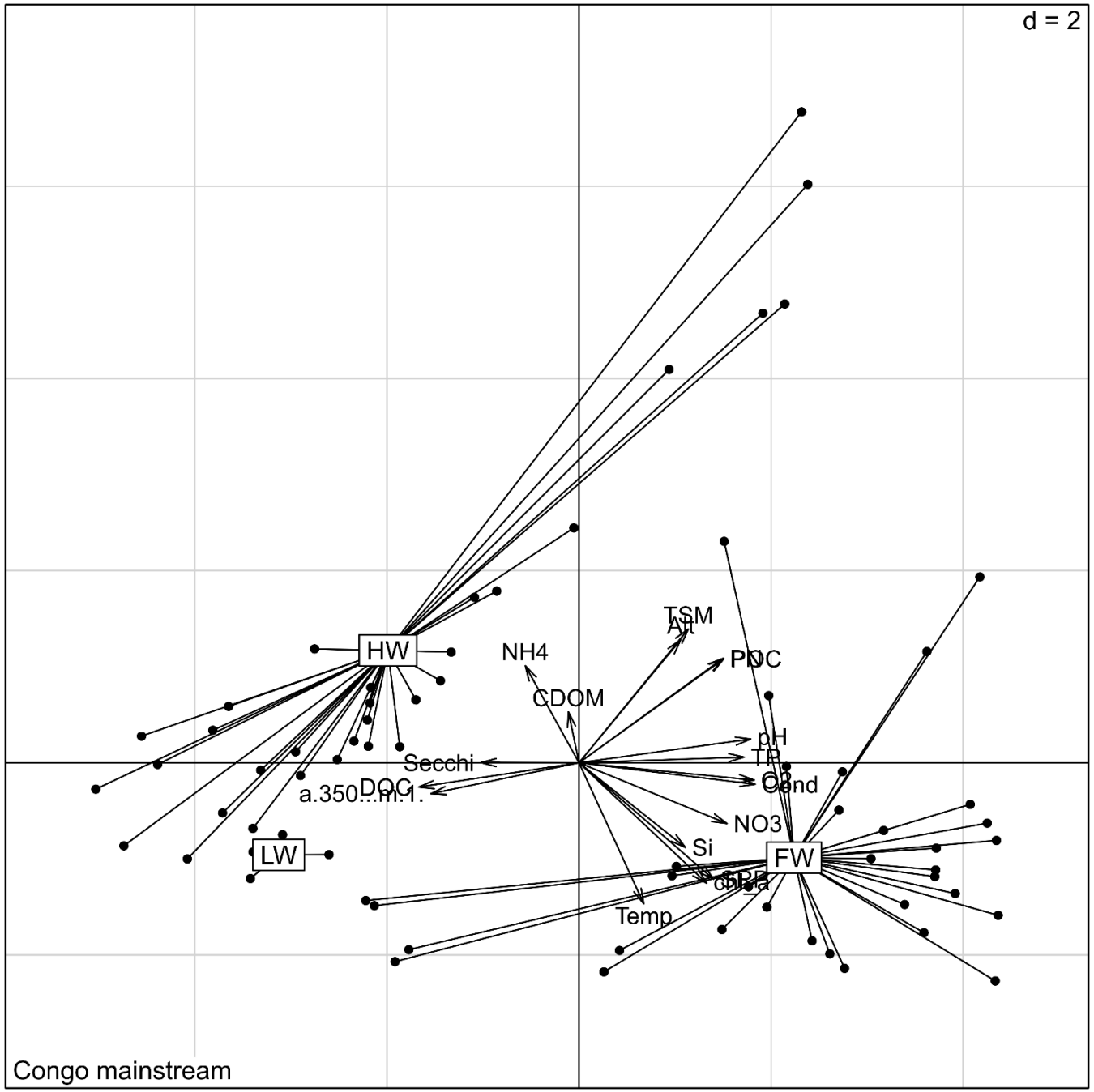




- High chlorophyll a in the main river (> 2 mg m^{-3})
- marked longitudinal increase, with maximum at km ~1000
- Dominance of diatoms, both in the main river, tributaries and lakes

The longitudinal dynamics suggest control by residence time

Phytoplankton composition contrasting with that of high waters, with strong diatom dominance



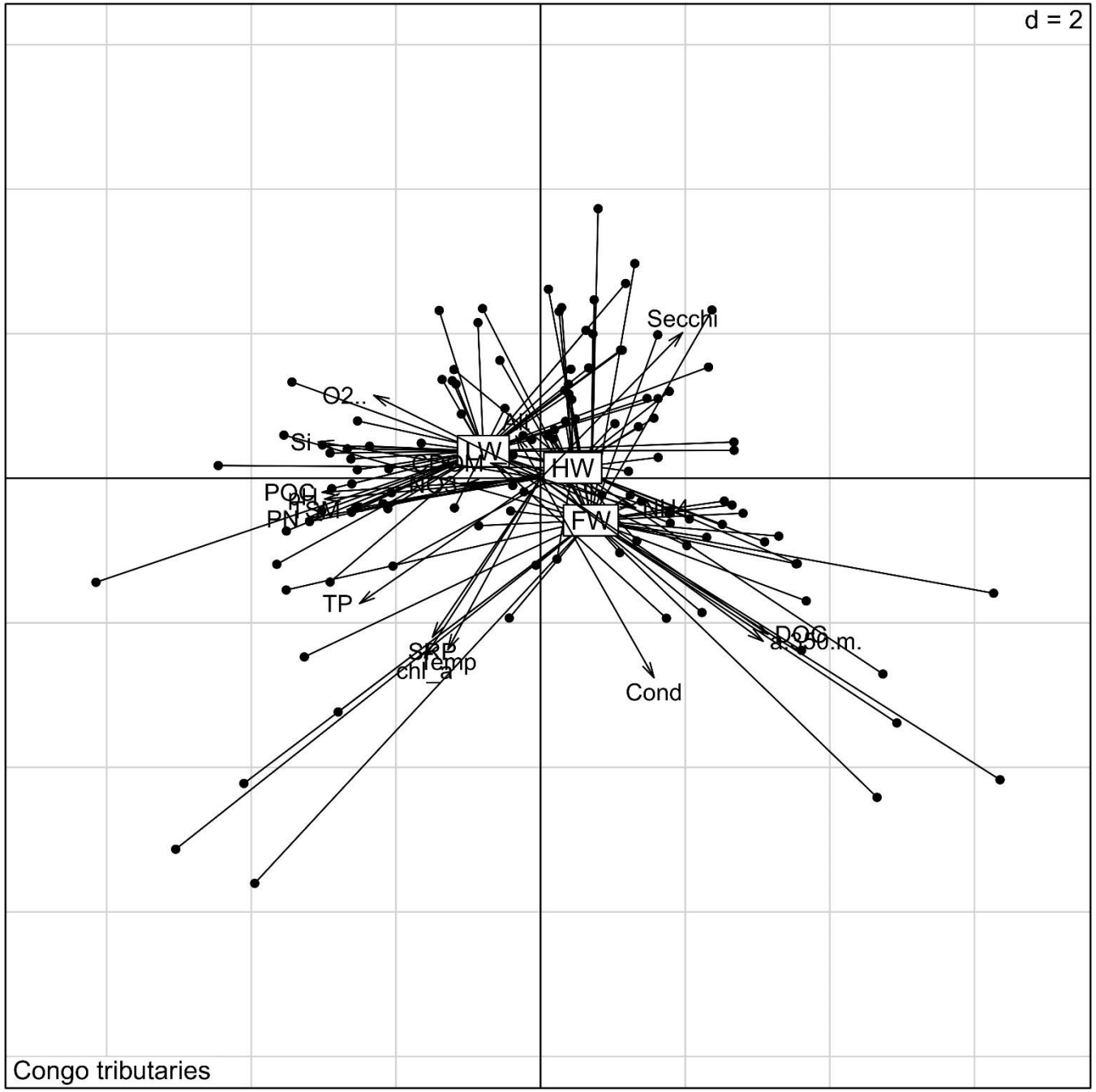
PCA on River Congo mainstem
Physical and chemical data (n = 71; p =)

Cumulated variance F1-F2 : 66.7 %

- Clear separation of the campaigns, particularly HW and FW
- HW : higher Secchi depth and dissolved organic matter; lower TSM, POC and nutrients
- FW : lower Secchi and DOM, higher nutrients, conductivity, pH and chlorophyll a

The differences result mainly from inputs from the forest soils in FW

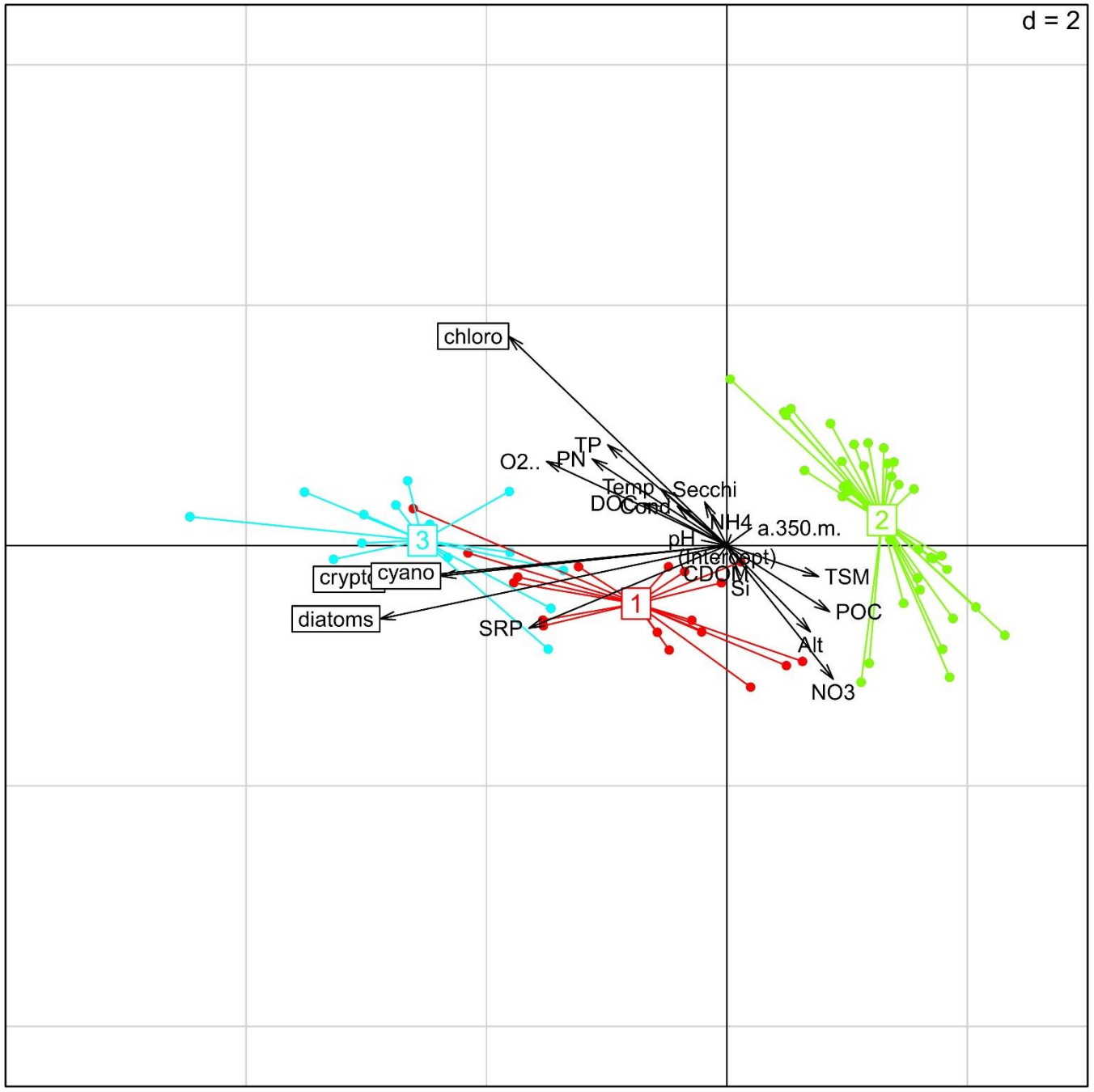
See previous publications …..



PCA on River Congo tributaries
Physical and chemical data (n = 119)

Cumulated variance F1-F2 : 47.3 %

Little difference among campaigns, unlike the mainstem

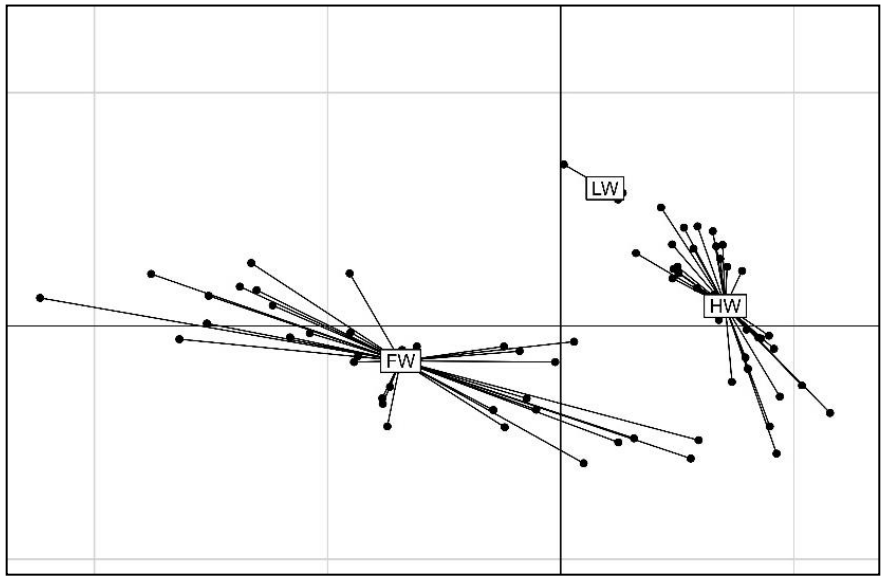


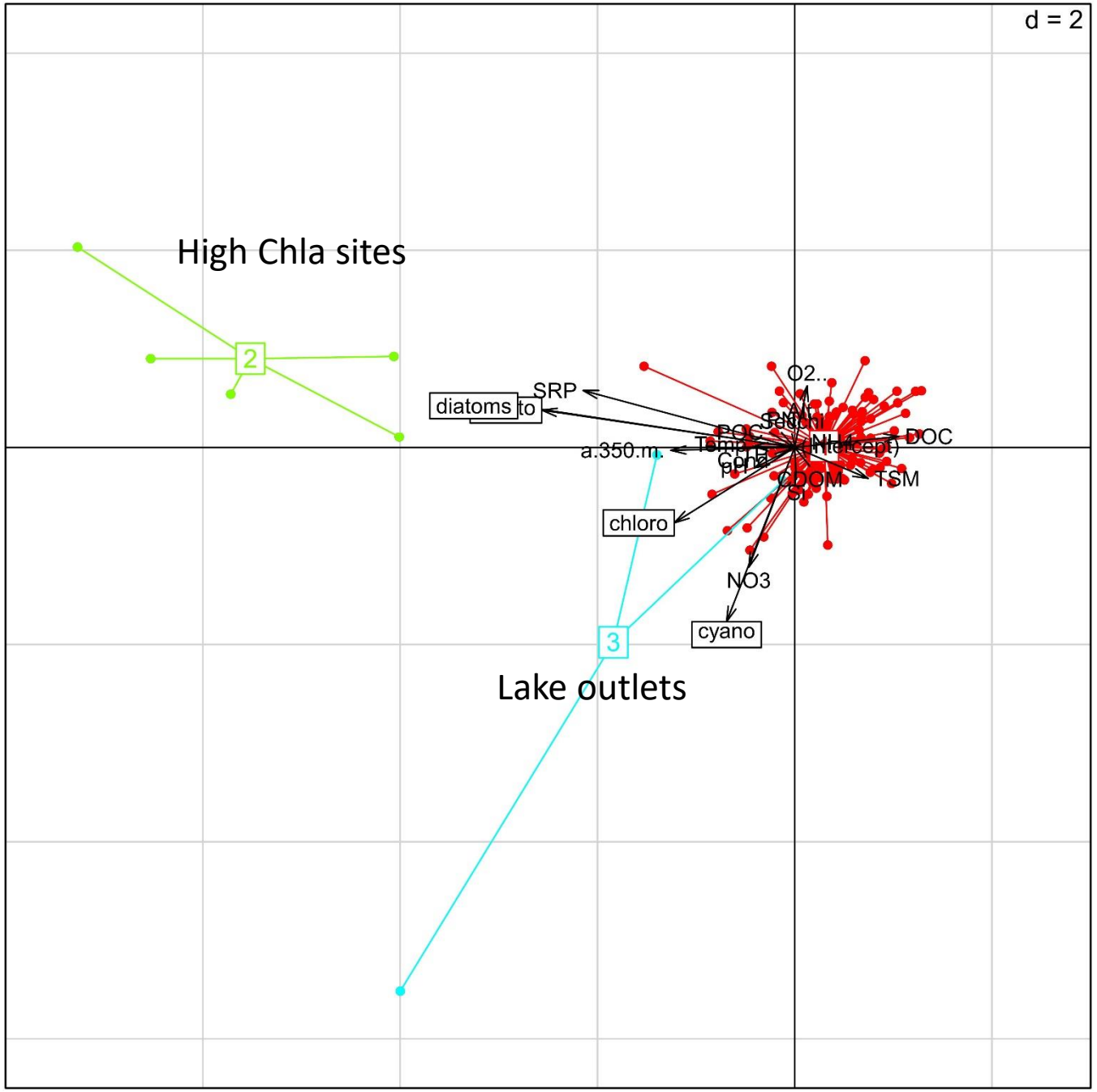
RDA on River Congo mainstem
Physical and chemical data + phytoplankton data

Inertia explained by P-C data : **85.2 %**

Different responses of phytoplankton groups:

- Diatoms, cyanoprokaryotes and cryptophytes correlated to SRP, and developed more in FW
- Green algae developed relatively better in HW, with lower TSM and POC, higher Secchi and lower dissolved nutrients ….





RDA on River Congo tributaries
Physical and chemical data + phytoplankton data (n = ; p =)

Inertia explained by P-C data : %

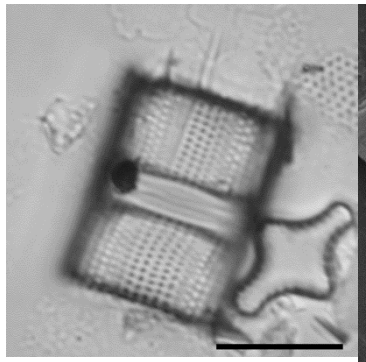
Stepwise linear regression on log group biomass

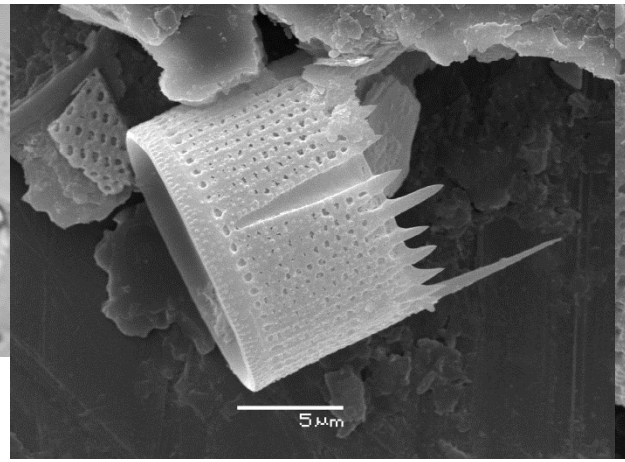
- On the whole data set : significant role of nutrients, conductivity, pH and DOC on assemblage composition

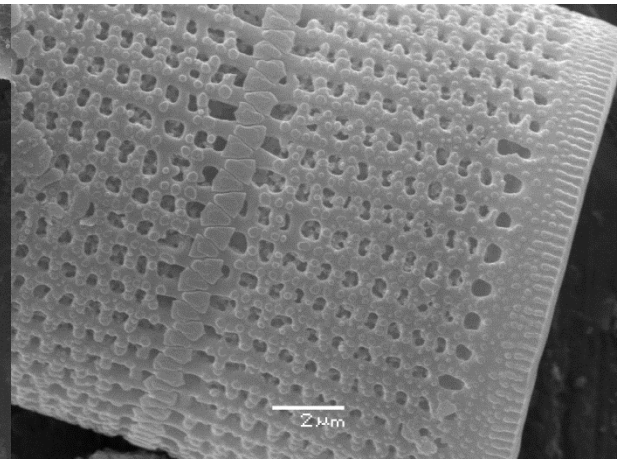
- On the mainstem data : similar results, but with altitude and temperature (proxies of residence time) as significant determinants

- On the tributaries : similar results, but lower R^2 and CDOM as additional explanatory variable

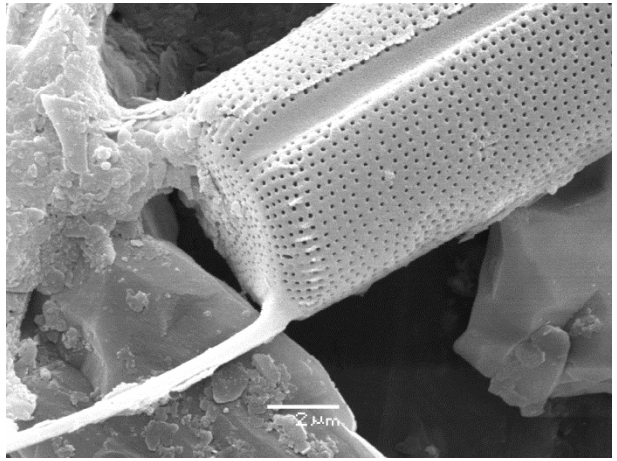
> 400 taxa identified



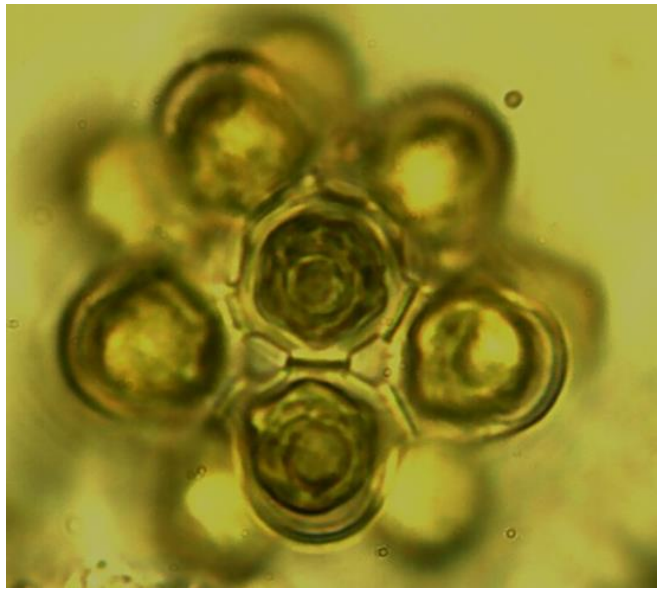




Aulacoseira agassizii

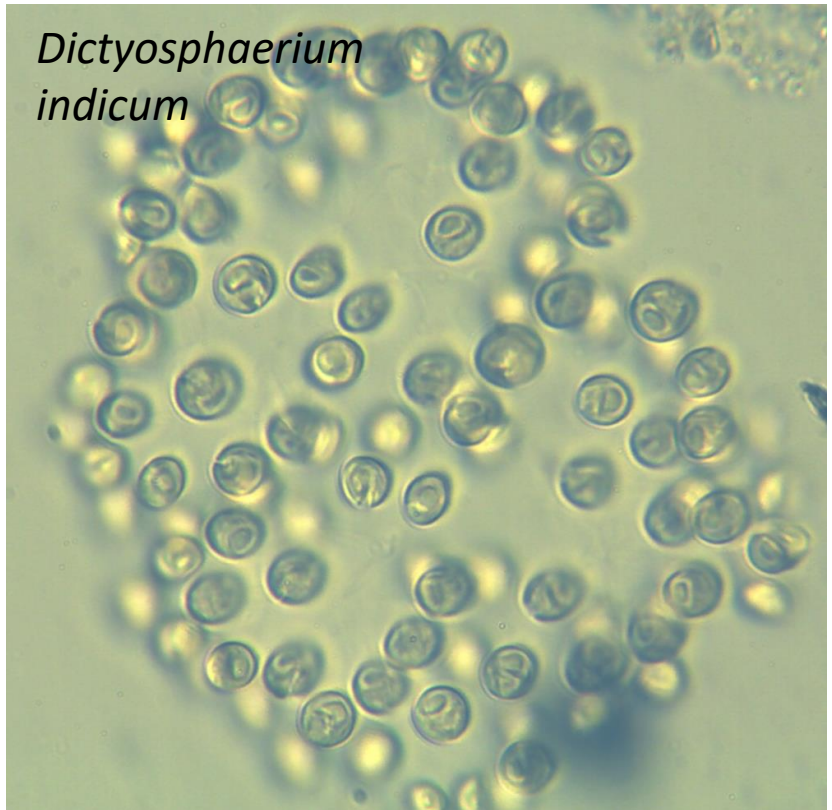


Aulacoseira herzogii

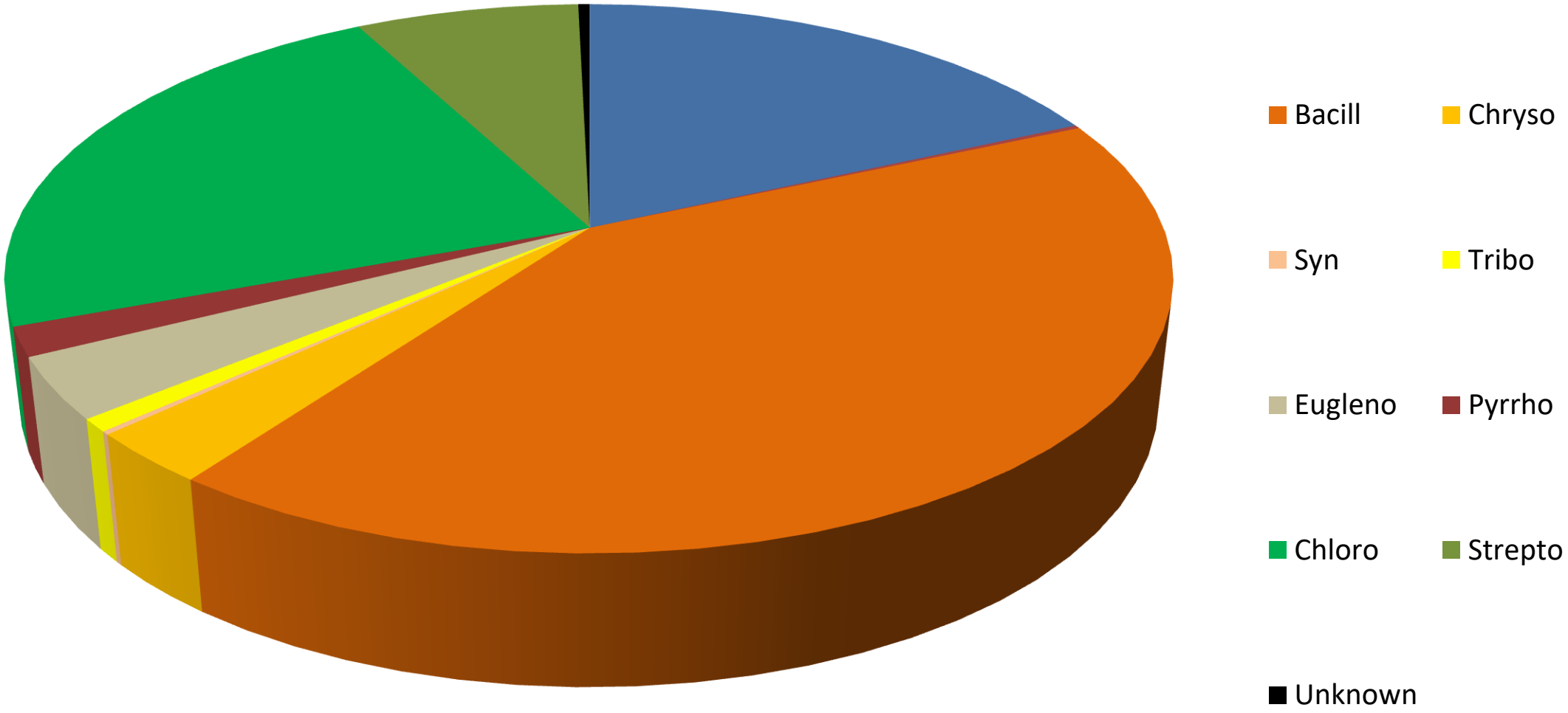


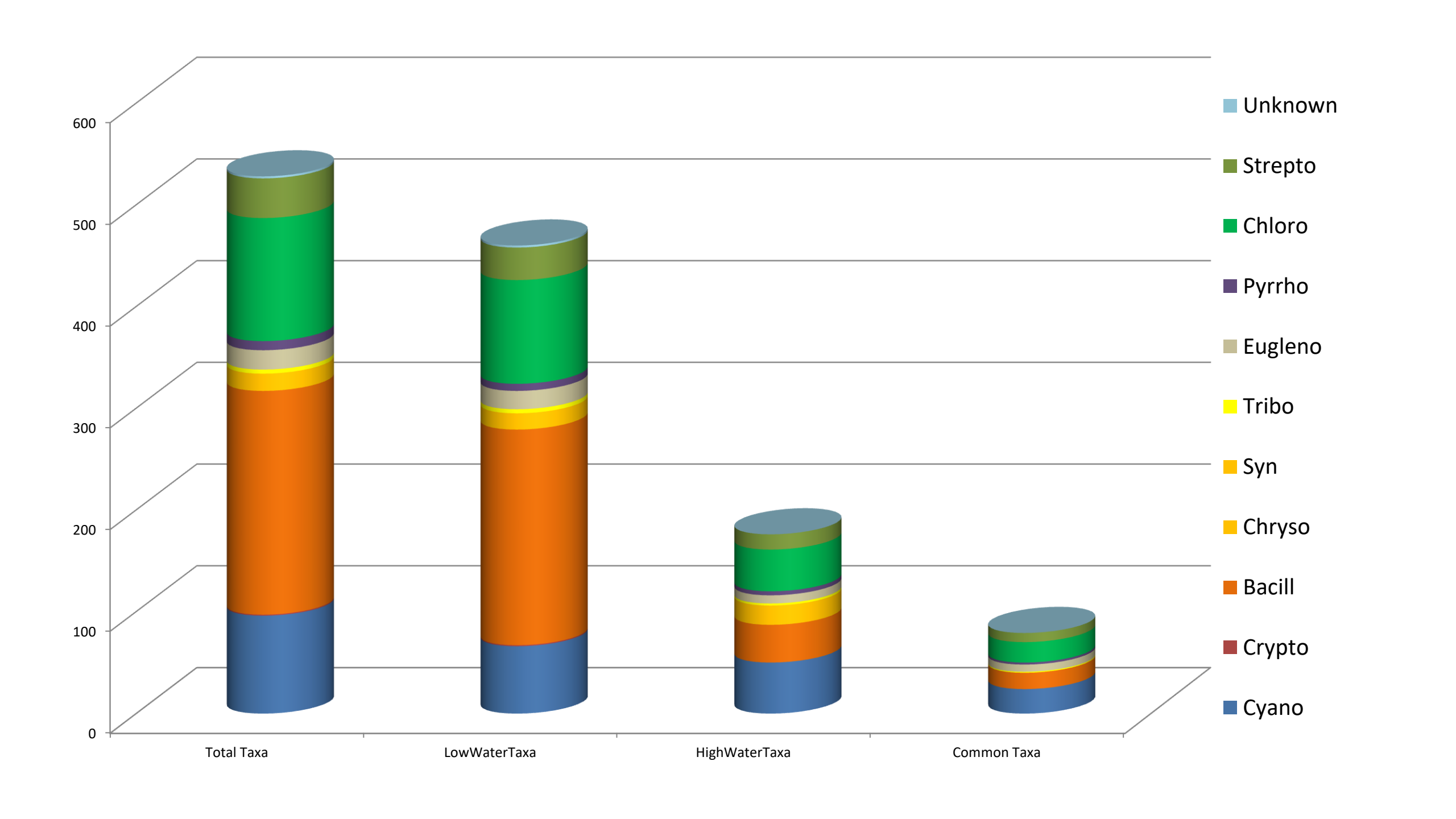
Coelastrum pseudomicroporum

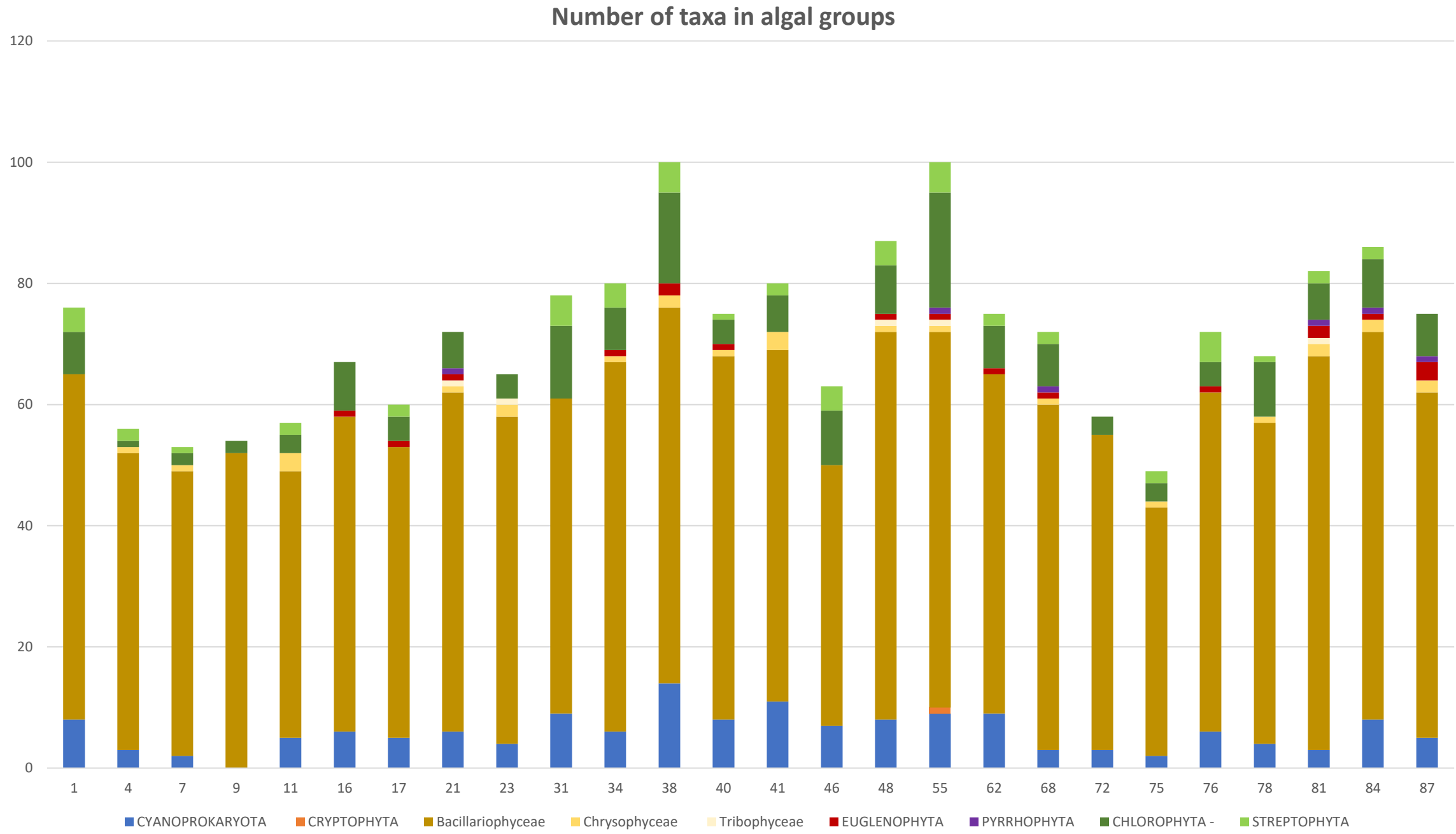
Dictyosphaerium indicum



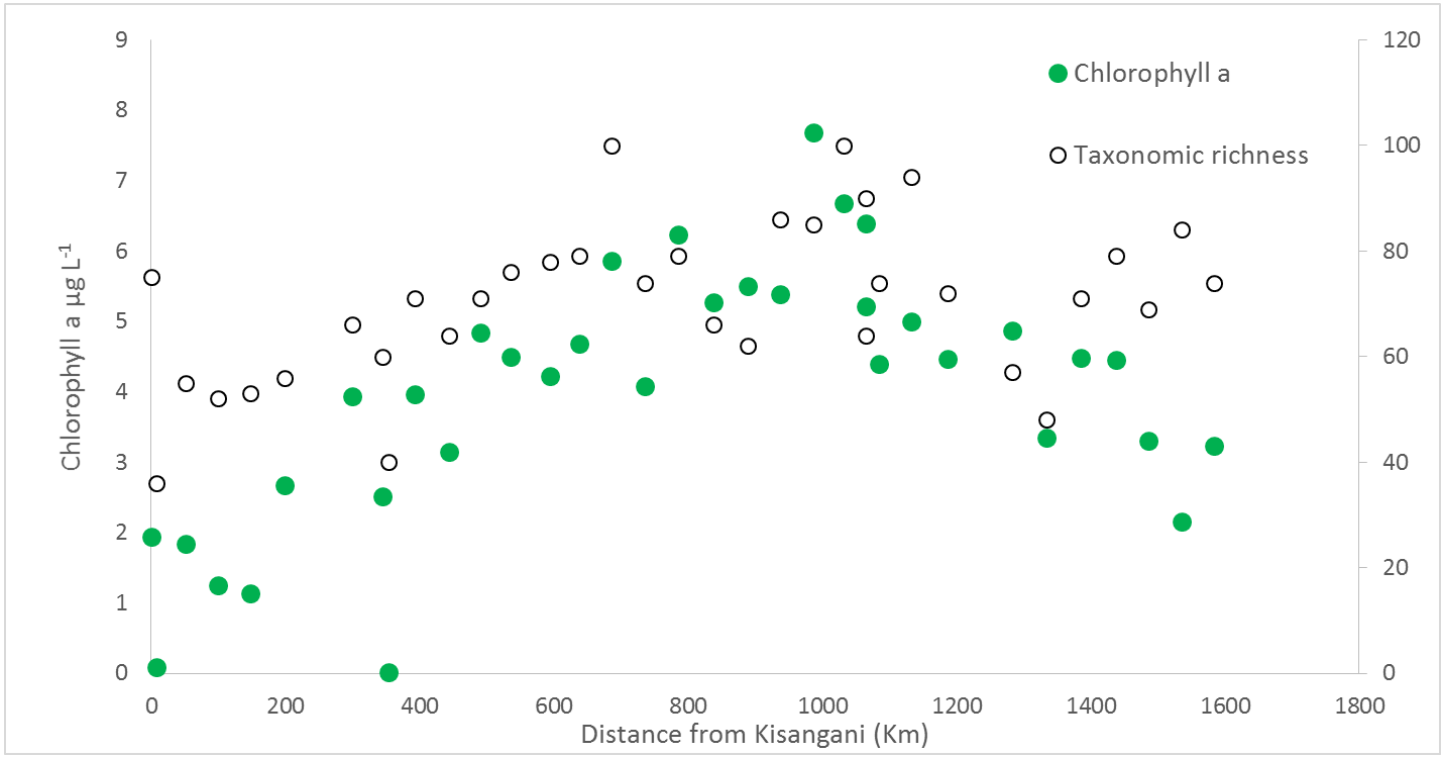
Taxonomic structure of Congo phytoplankton

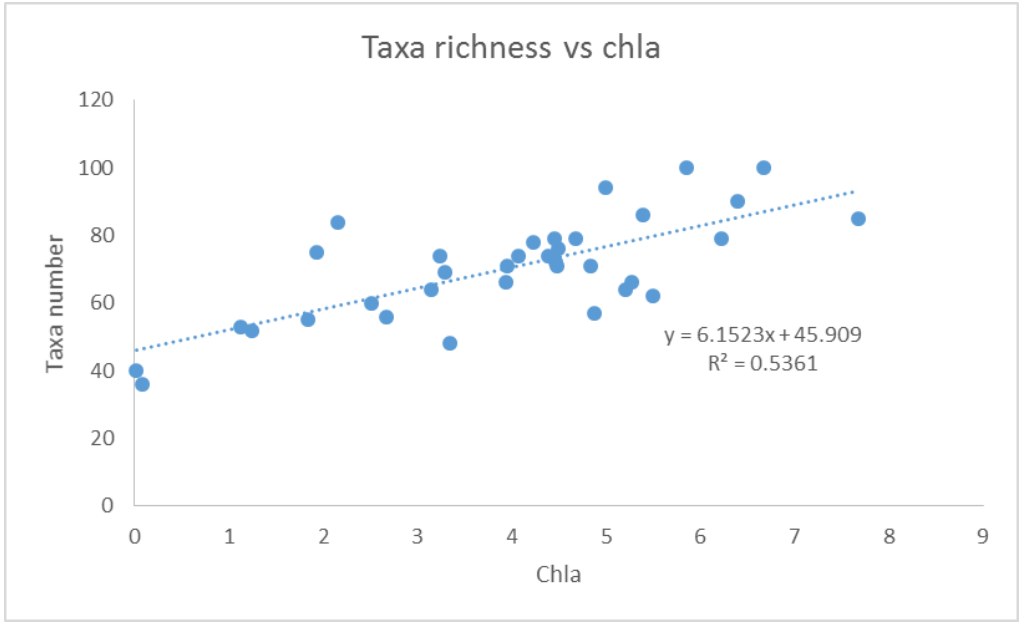



600
500
400
300
200
100
0
Total Taxa
LowWaterTaxa
HighWaterTaxa
Common Taxa
Unknown
Strepto
Chloro
Pyrrho
Eugleno
Tribo
Syn
Chryso
Bacill
Crypto
Cyano

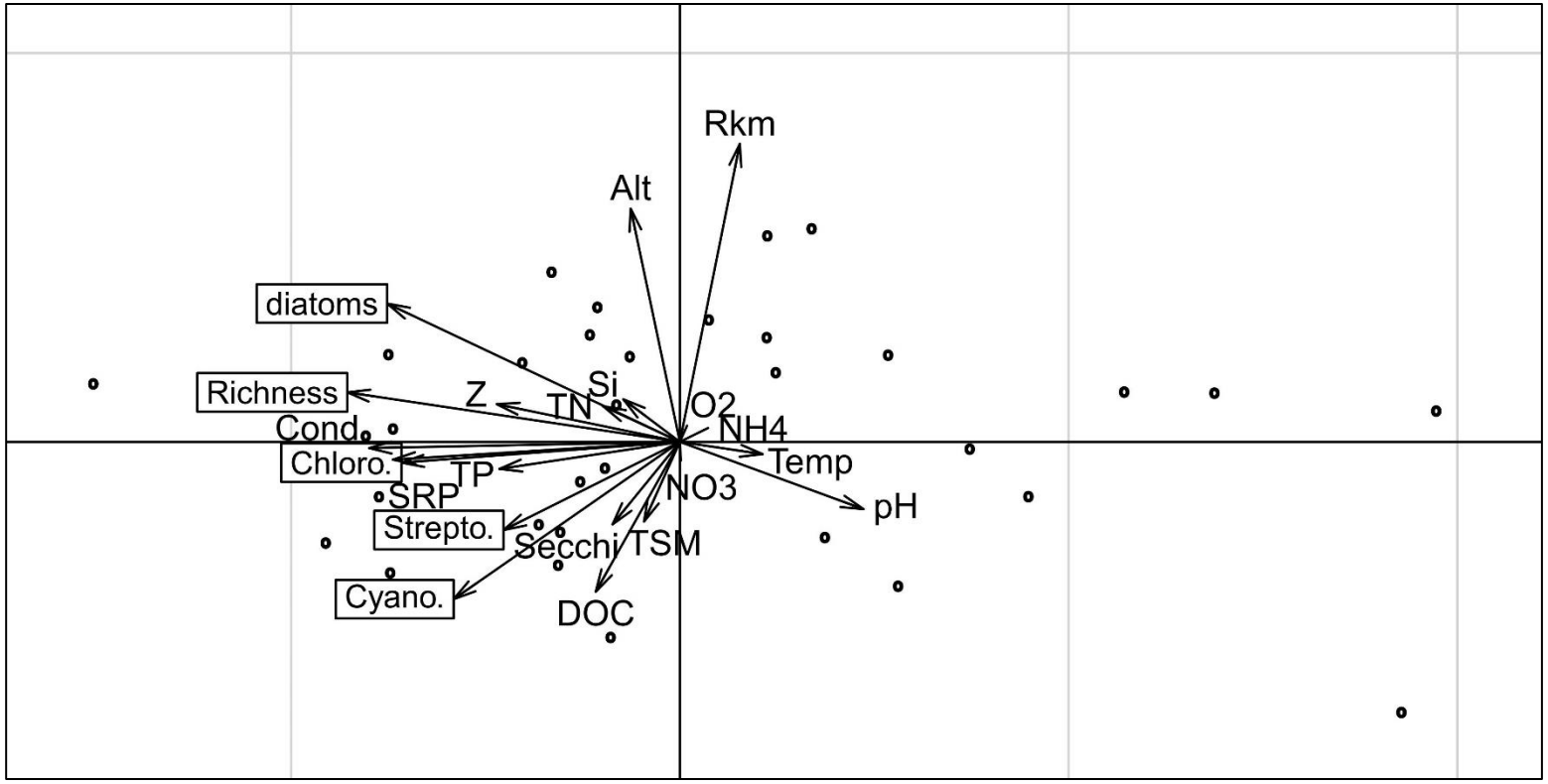

Number of taxa in algal groups
120
100
80
60
40
20
0
1
4
7
9
11
16
17
21
23
31
34
38
40
41
46
48
55
62
68
72
75
76
78
81
84
87
CYANOPROKARYOTA
CRYPTOPHYTA
Bacillariophyceae
Chrysophyceae
Tribophyceae
EUGLENOPHYTA
PYRRHOPHYTA
CHLOROPHYTA -
STREPTOPHYTA

Taxonomic diversity (species level) Congo mainstem + Oubangui)





How to explain the chlorophyll a – taxonomic richness correlation (FW samples)?



RDA on group taxa richness and environmental variables:
Taxa richness responds to the same variables as chlorophyll a: nutrients (TP, SRP), Secchi depth, DOC, with an additional possible role of conductivity

Summary and conclusions

- In the Congo River and tributaries, there were strong « seasonal » differences in phytoplankton biomass and composition; they may reflect different hydrological conditions but also different inputs from the watershed
- The main drivers of the composition at class/group level were **nutrient concentration** (prominent role of SRP) and **light availability** (depending on TSM affecting Secchi depth, but also on CDOM in tributaries); green algae responded better when TN, TP were higher, NO3 lower but likely the improved light conditions related to lower TSM of the HW campaign were the main factor
- Taxonomic diversity at species level was high and was correlated to chlorophyll a variation in the main river in FW conditions : the same environmental drivers seem to be involved, with some differences among phytoplankton groups, which would need further research

- Still to be explored : the share of benthic vs. planktonic taxa in the variation of taxonomic diversity, the role of inputs from tributaries, the role of channel complexity and hydrodynamics
- There is a need of similar studies in large tropical rivers : few comprehensive studies were carried out along a long longitudinal gradient

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