Human Impacts on ecosystem health and resources of Lake Edward (HIPE): the phytoplankton study

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ELLS-IAGLR-2018 / September 23-28, 2018 / Evian (France)

HIPE

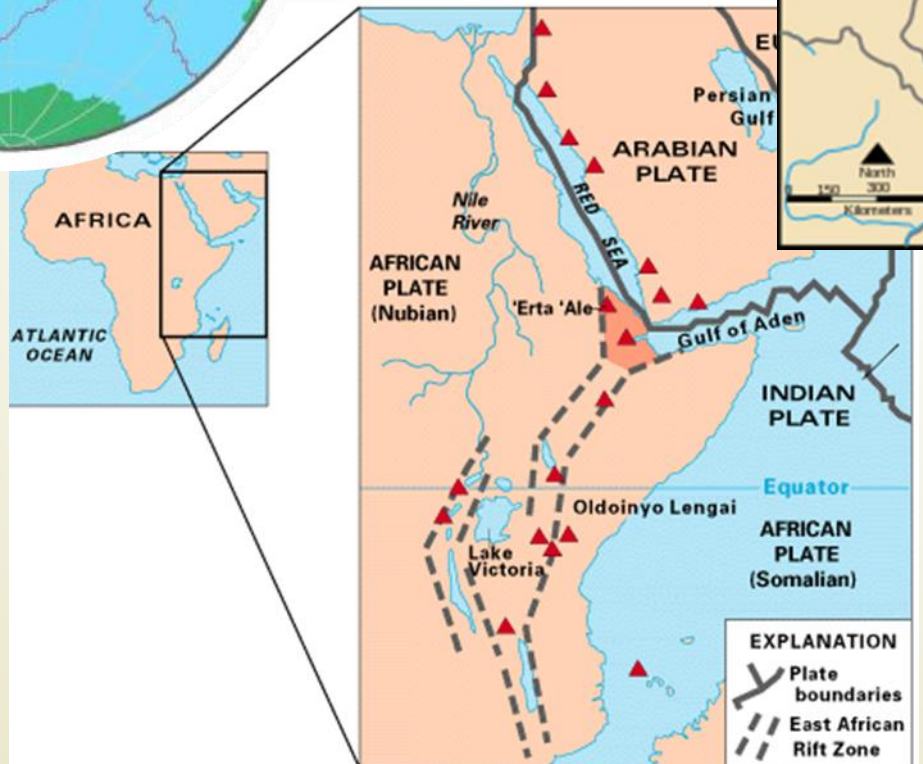
HUMAN IMPACTS ON ECOSYSTEM HEALTH AND RESOURCES OF LAKE EDWARD

funded by the Belgian Federal Science Policy Office
under BRAIN-Be
CONTRAT N° BR/154/A1/HIPE
15 December 2015 - 30 March 2020

ELLS-IAGLR-2018 / September 23-28, 2018 / Evian (France)

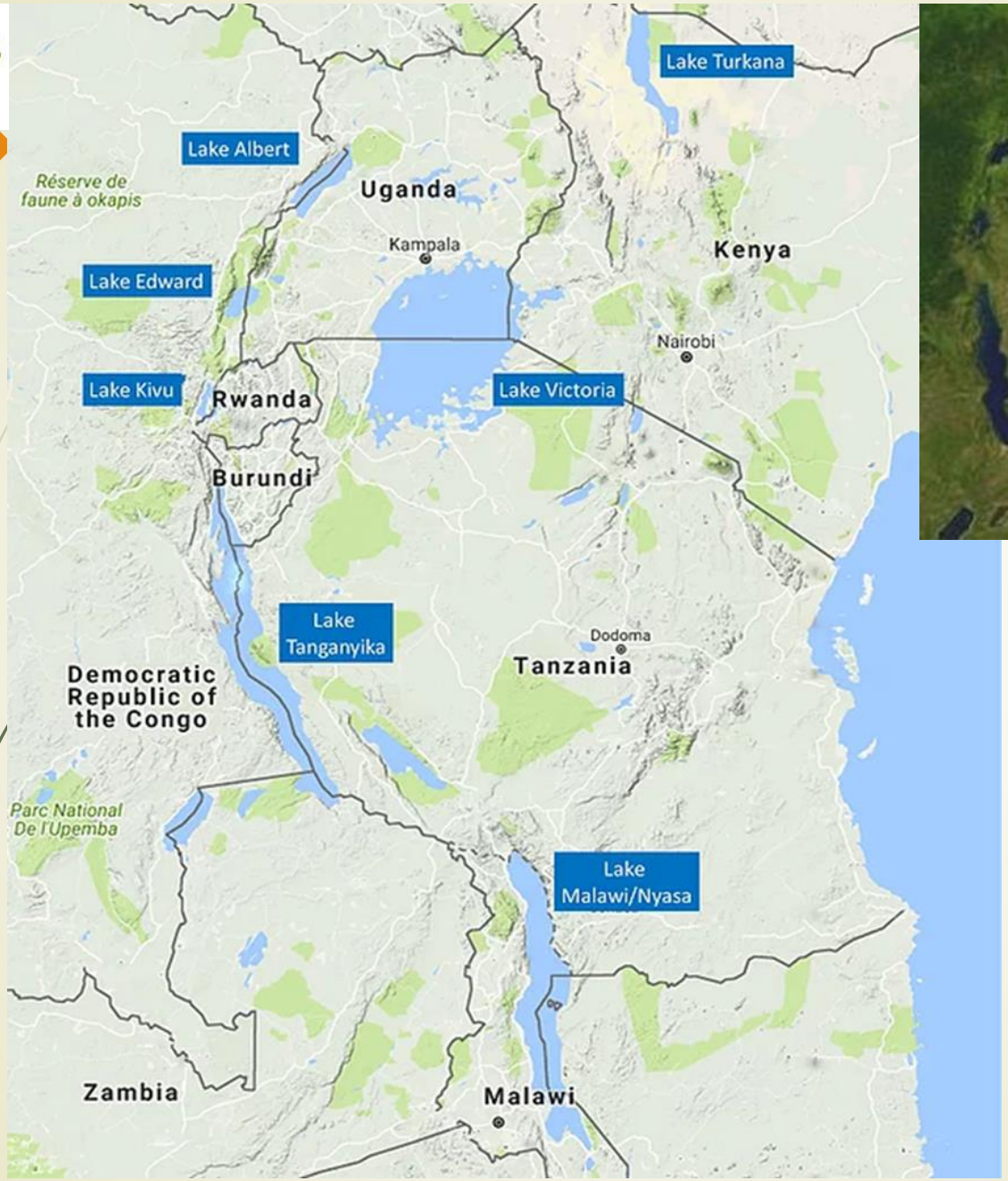
L. Edward

Rutanzige or Edward Nyanza

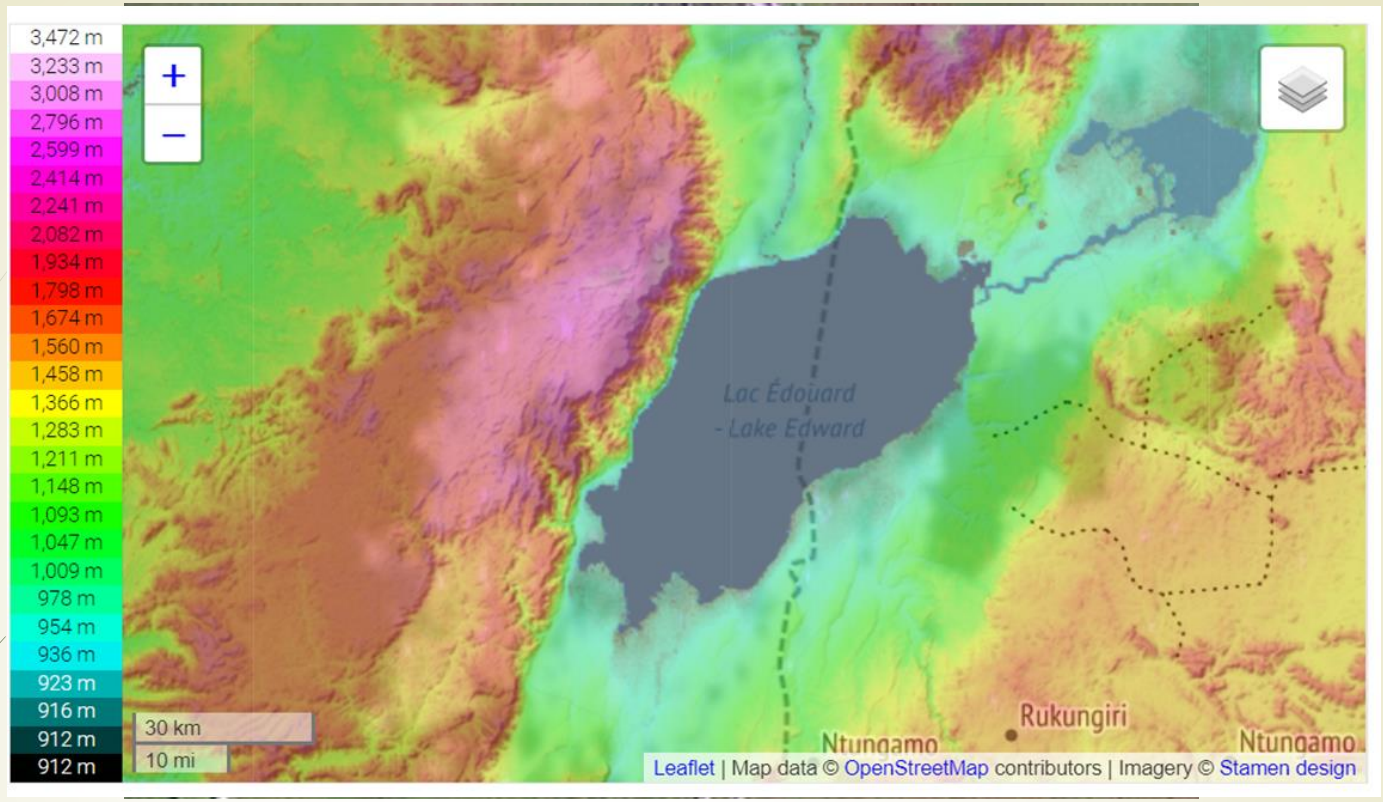


African Great Lakes

East African Rift



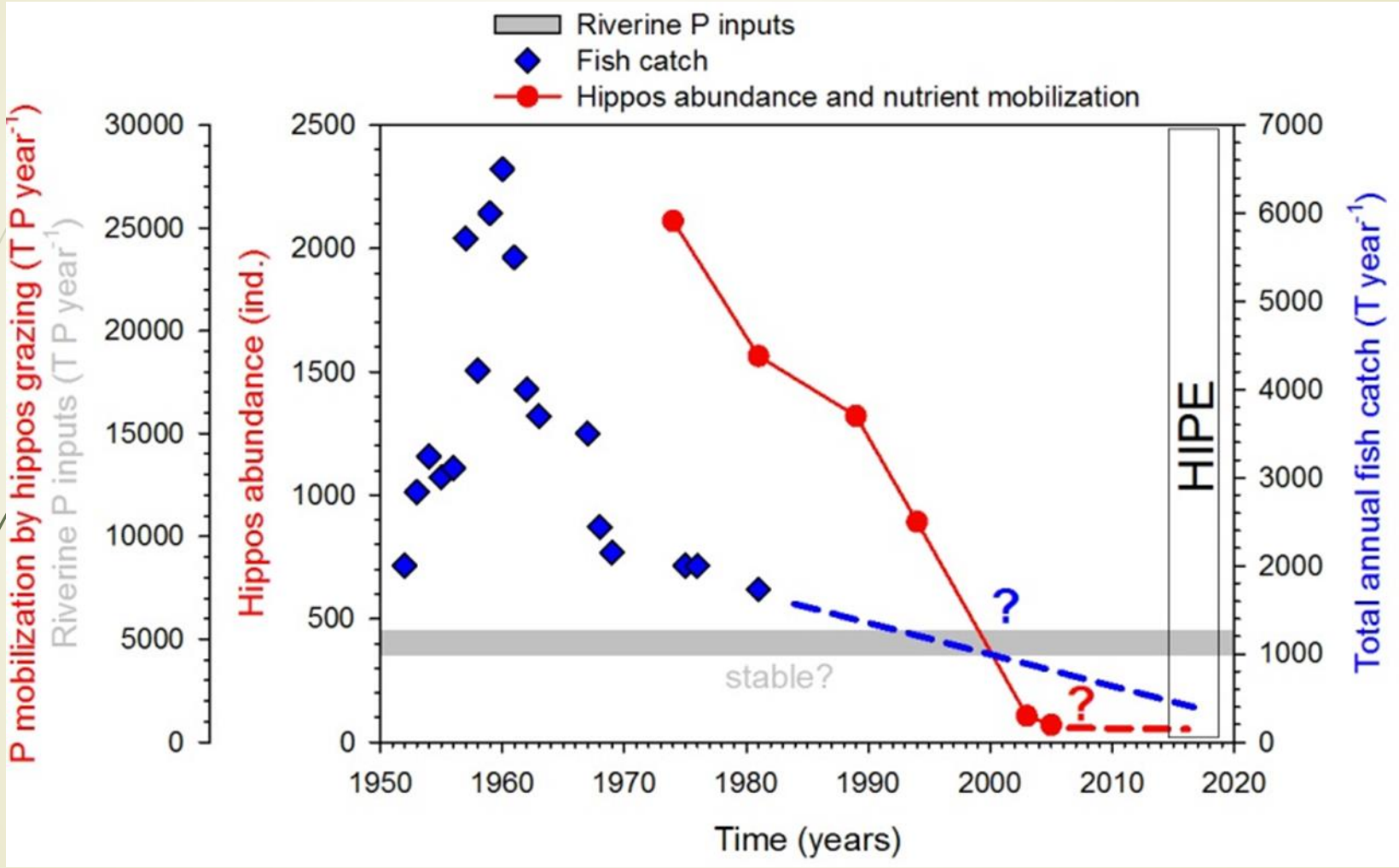
large,
deep,
weakly stratified
tropical lake



Max. length 77 km (48 mi)
Max. width 40 km (25 mi)
Surface area 2,325 km2 (898 sq mi)
Average depth 17 m (56 ft)
Max. depth 112 m (367 ft)
Water volume 39.5 km3 (9.5 cu mi)
Surface elevation 912 m (2,992 ft)

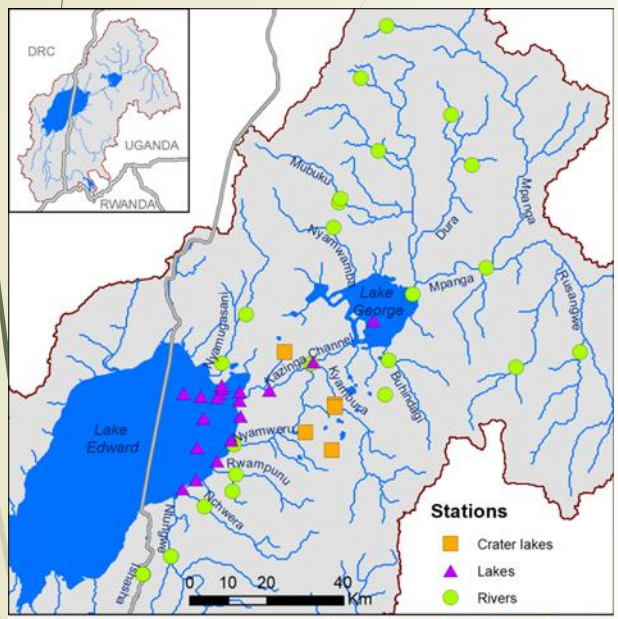
Lake Edward

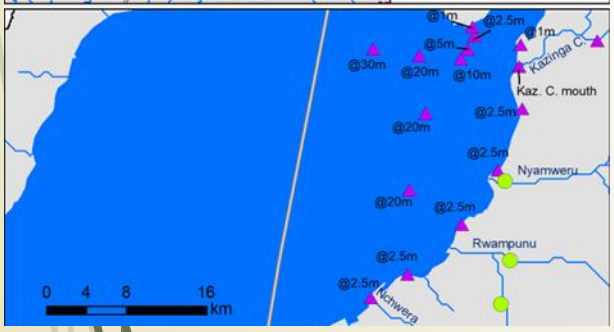
Background data

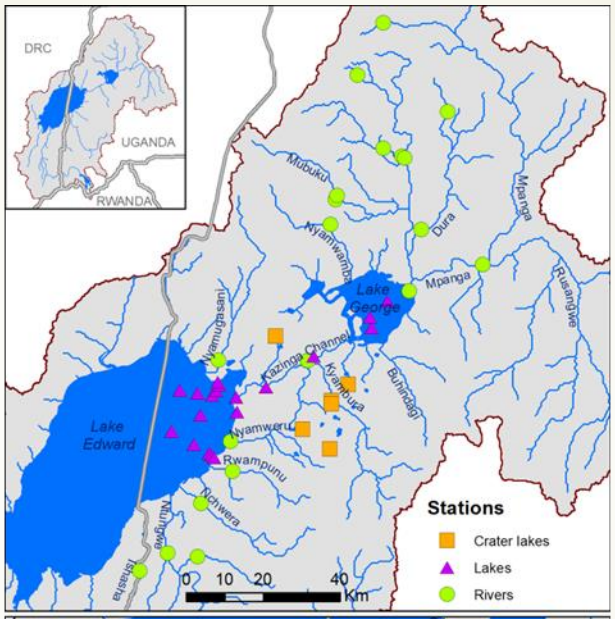


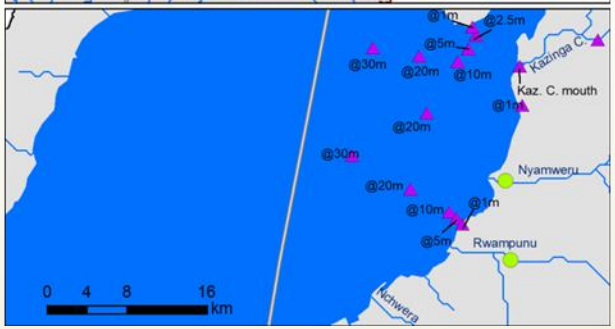
Working hypothesis:
several environmental pressures have disrupted the biogeochemical, structural and functional links between the terrestrial and the aquatic ecosystem,
leading to a collapse of the main ecosystem service.

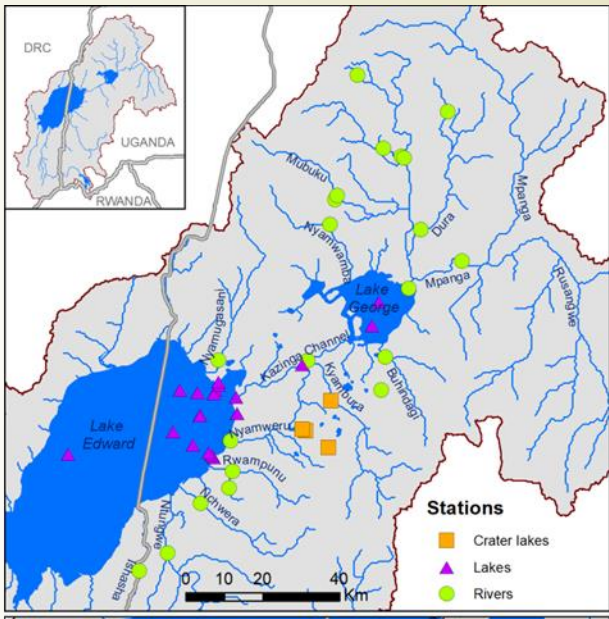
Cruises 2016-2018/HIPE1, HIPE2 and HIPE3

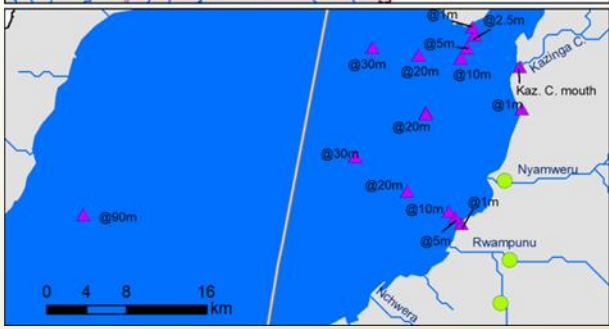


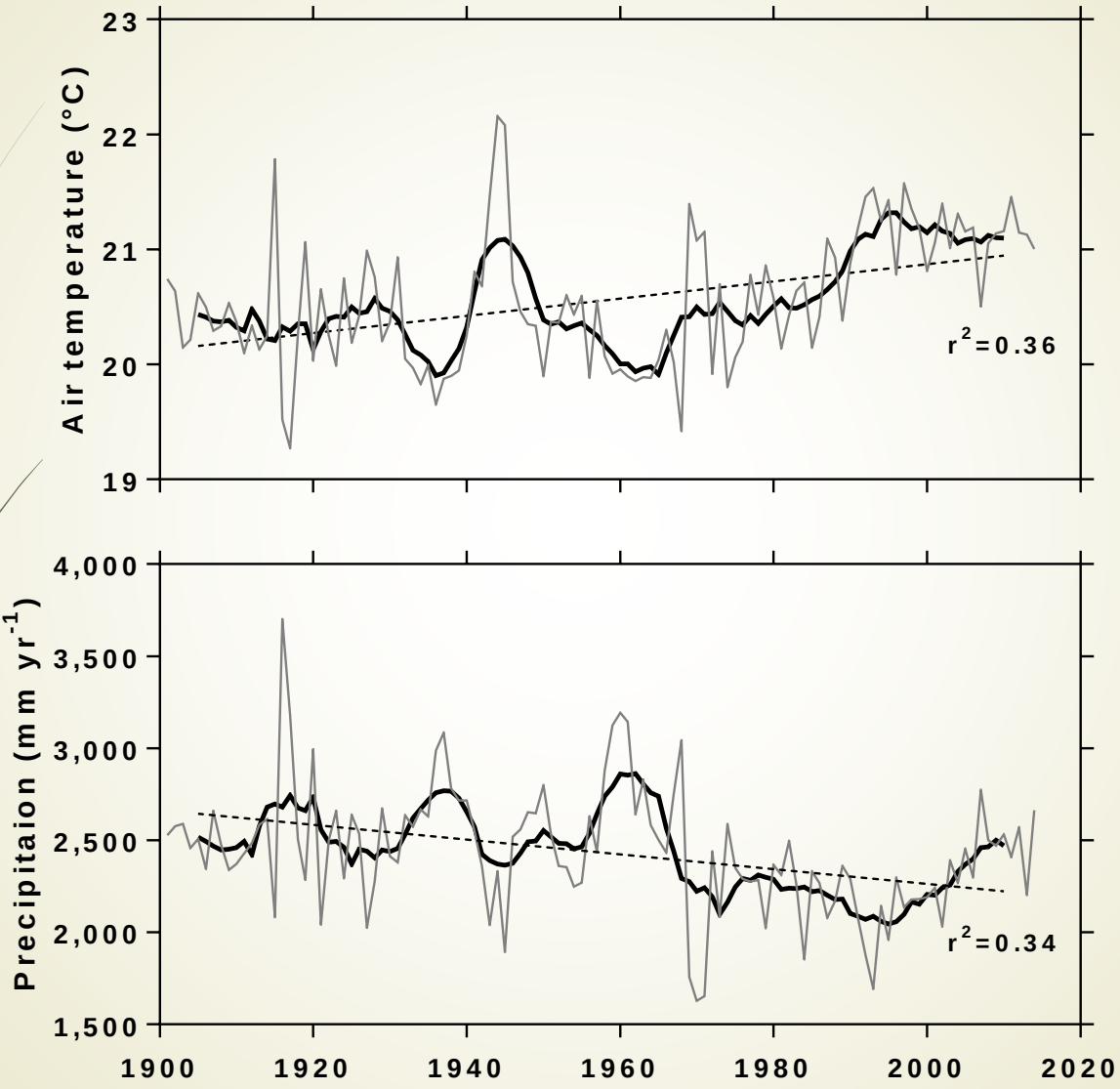




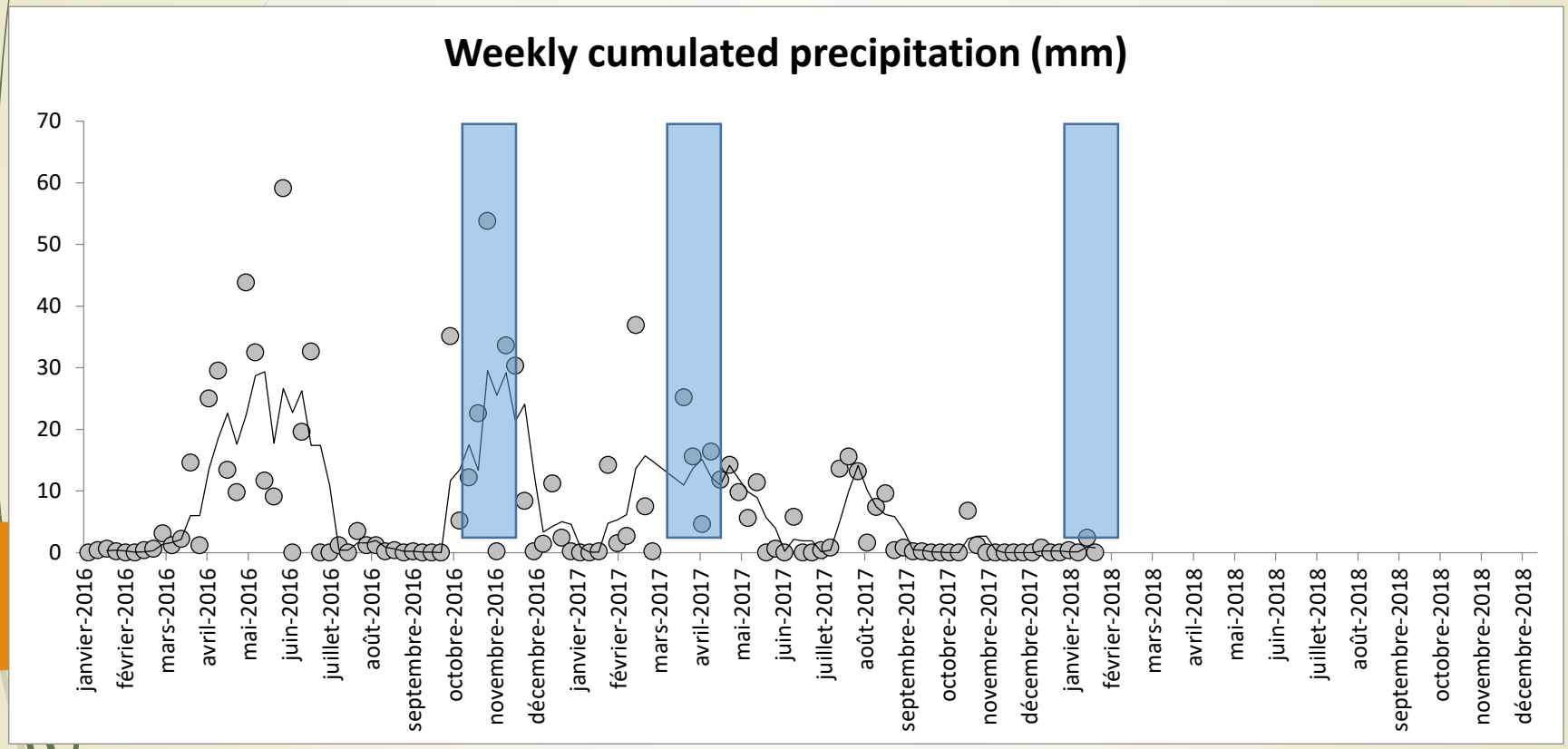




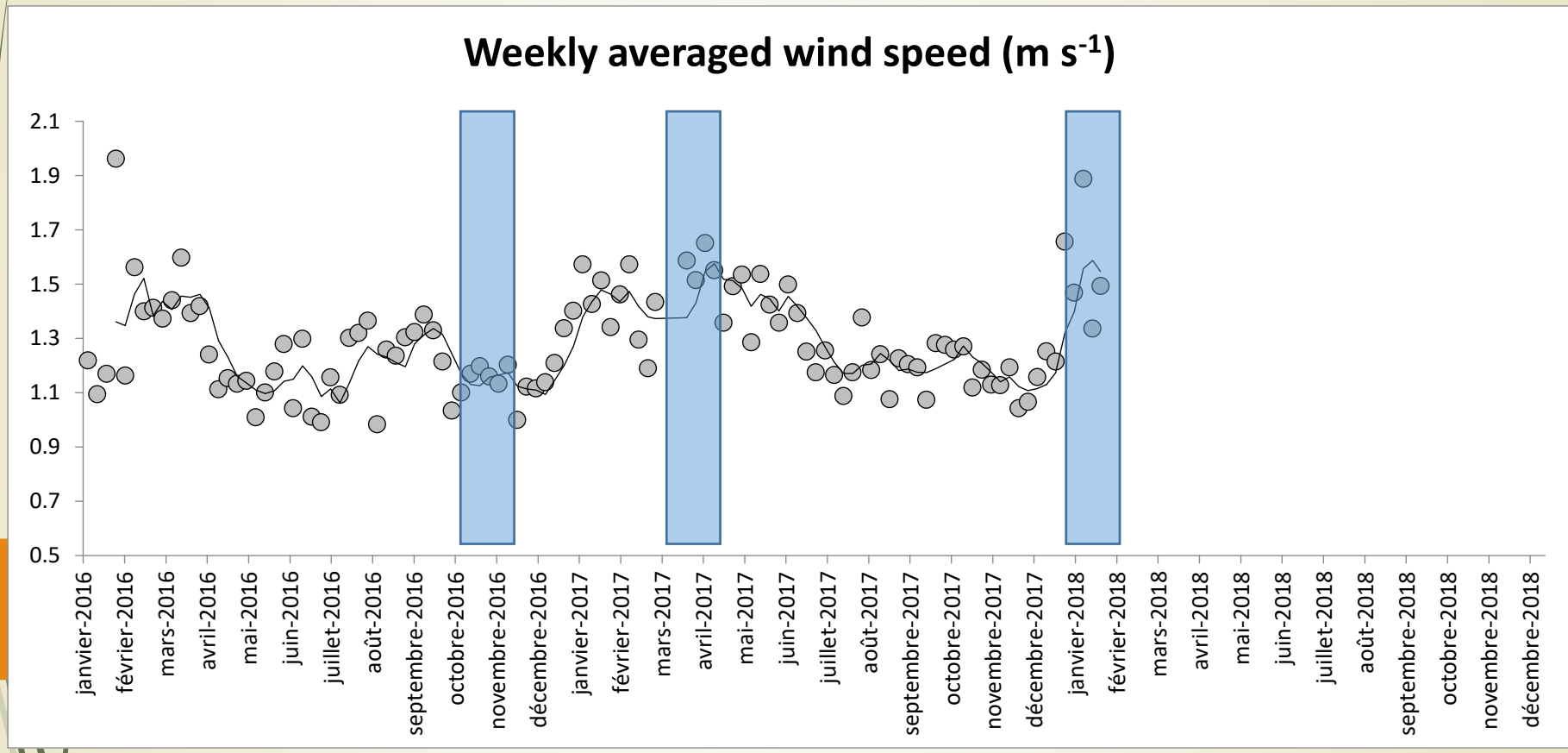



Air temperature (°C)
23
22
21
20
19
r²=0.36
Precipitaion (mm yr⁻¹)
4,000
3,500
3,000
2,500
2,000
1,500
r²=0.34
1900
1920
1940
1960
1980
2000
2020

Cruises


Weekly cumulated precipitation (mm)
70
60
50
40
30
20
10
0
janvier-2016
février-2016
mars-2016
avril-2016
mai-2016
juin-2016
juillet-2016
août-2016
septembre-2016
octobre-2016
novembre-2016
décembre-2016
janvier-2017
février-2017
mars-2017
avril-2017
mai-2017
juin-2017
juillet-2017
août-2017
septembre-2017
octobre-2017
novembre-2017
décembre-2017
janvier-2018
février-2018
mars-2018
avril-2018
mai-2018
juin-2018
juillet-2018
août-2018
septembre-2018
octobre-2018
novembre-2018
décembre-2018

Cruises


Weekly averaged wind speed (m s-1)
2.1
1.9
1.7
1.5
1.3
1.1
0.9
0.7
0.5
janvier-2016
février-2016
mars-2016
avril-2016
mai-2016
juin-2016
juillet-2016
août-2016
septembre-2016
octobre-2016
novembre-2016
décembre-2016
janvier-2017
février-2017
mars-2017
avril-2017
mai-2017
juin-2017
juillet-2017
août-2017
septembre-2017
octobre-2017
novembre-2017
décembre-2017
janvier-2018
février-2018
mars-2018
avril-2018
mai-2018
juin-2018
juillet-2018
août-2018
septembre-2018
octobre-2018
novembre-2018
décembre-2018

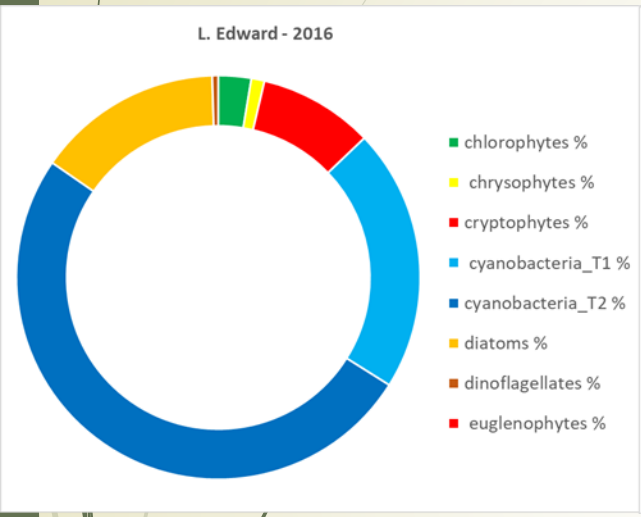
Phytoplankton study

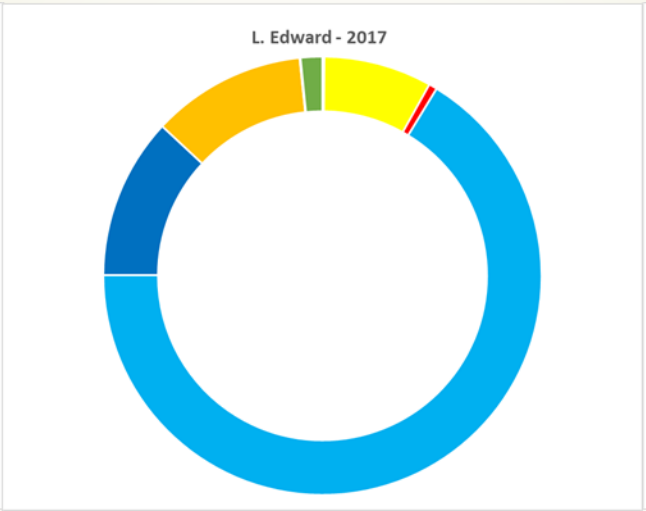
HPLC

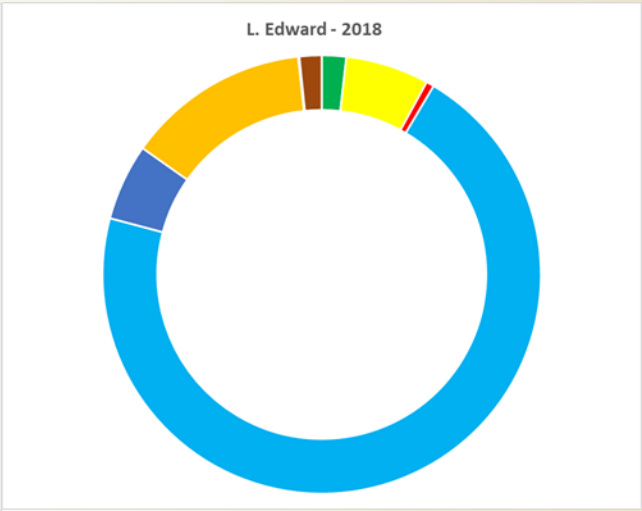
Microscopy: Light microscopy
SEM

97 + 122 + 179 samples (398)
also from L. George, crater lakes and rivers) – **134 from L. Edward** (29+49+56)

HPLC data on L. Edward phytoplankton





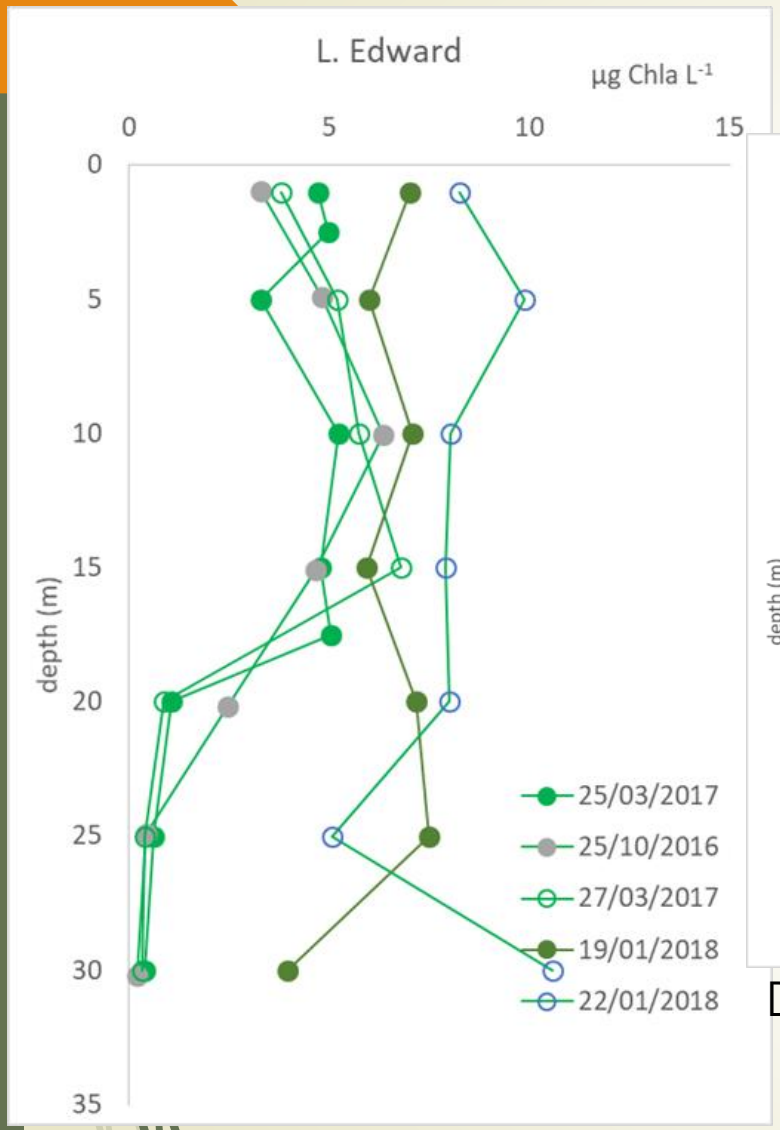


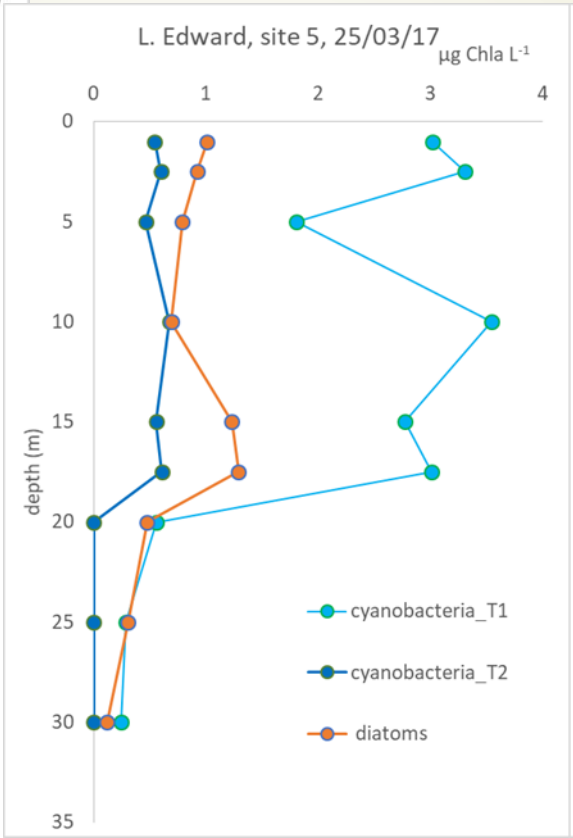
Phytoplankton marker pigments in water column samples (134)

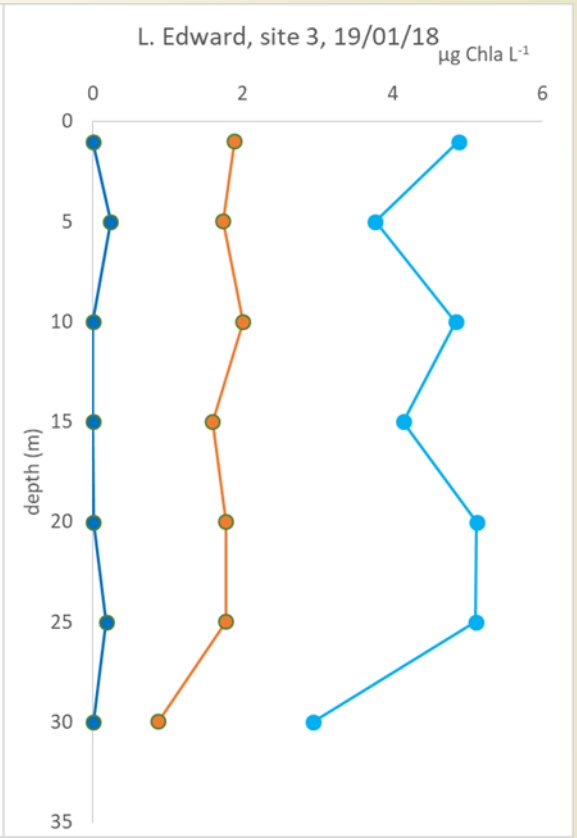
Average composition: little variation among cruises

High contribution of Cyanoprokaryota/Cyanobacteria and diatoms

Vertical distribution of chlorophyll a and main groups







Depth of mixed layer > euphotic zone (max 5 m)

Strong light limitation

Historical data on L. Edward phytoplankton

Mission H. Damas (1935-36)

Taxa reported for the smaller East African Rift lakes

	Albert*	Edward**	Kivu**	Rukwa***
Cyanobacteria	6	33	15	4
Chlorophyta	24	63	17	7
Xanthophyta	1	1		
Bacillariophyta	14	185	132	76
Dinophyta	2			
Euglenophyta	1			
Total	48	282	164	87

* Reports from WEST (1907) and BACHMANN (1933) included for Lake Albert.
** Reports from CONRAD (1949), FREMY (1949), HUSTEDT (1949) and PASCHER (1949) included for Lake Edward and Lake Kivu.
*** Reports from SCHMIDLE (1904) and MULLER (1905) included for Lake Rukwa.

Phytoplankton composition: historical data

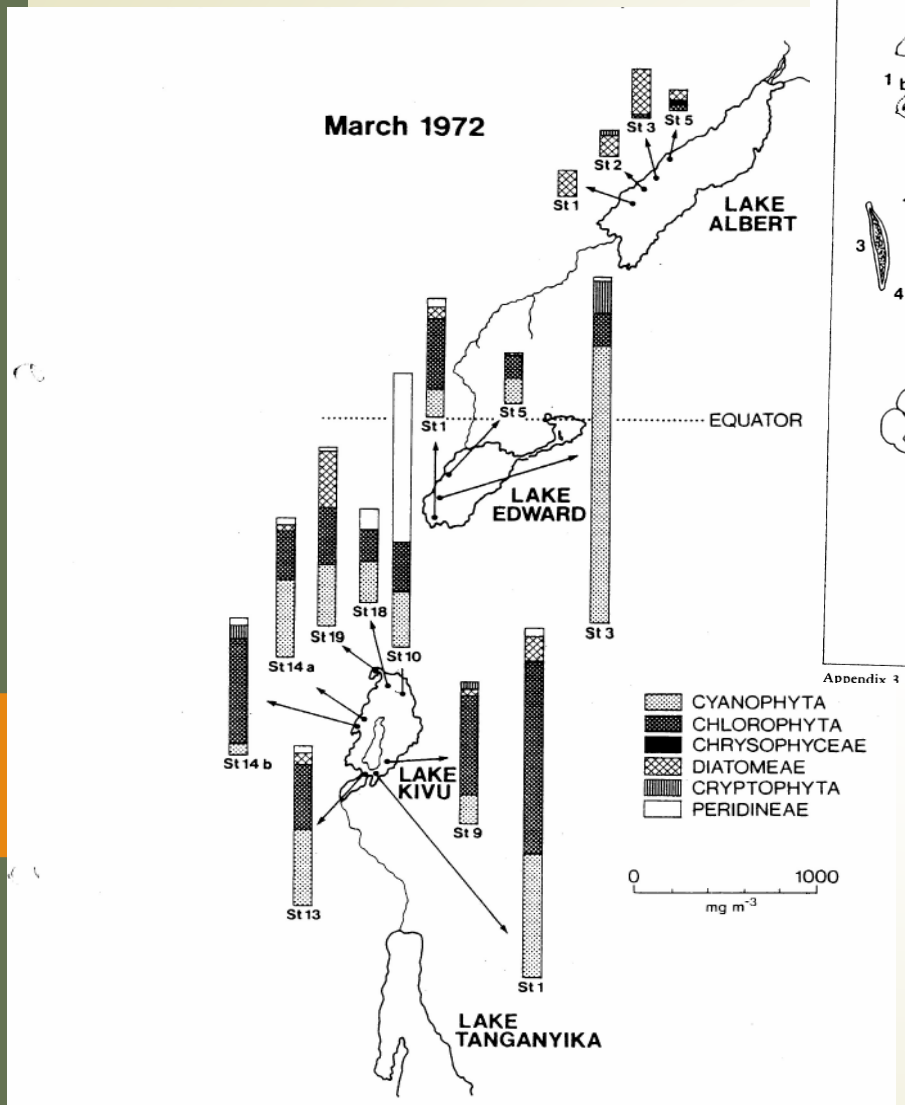
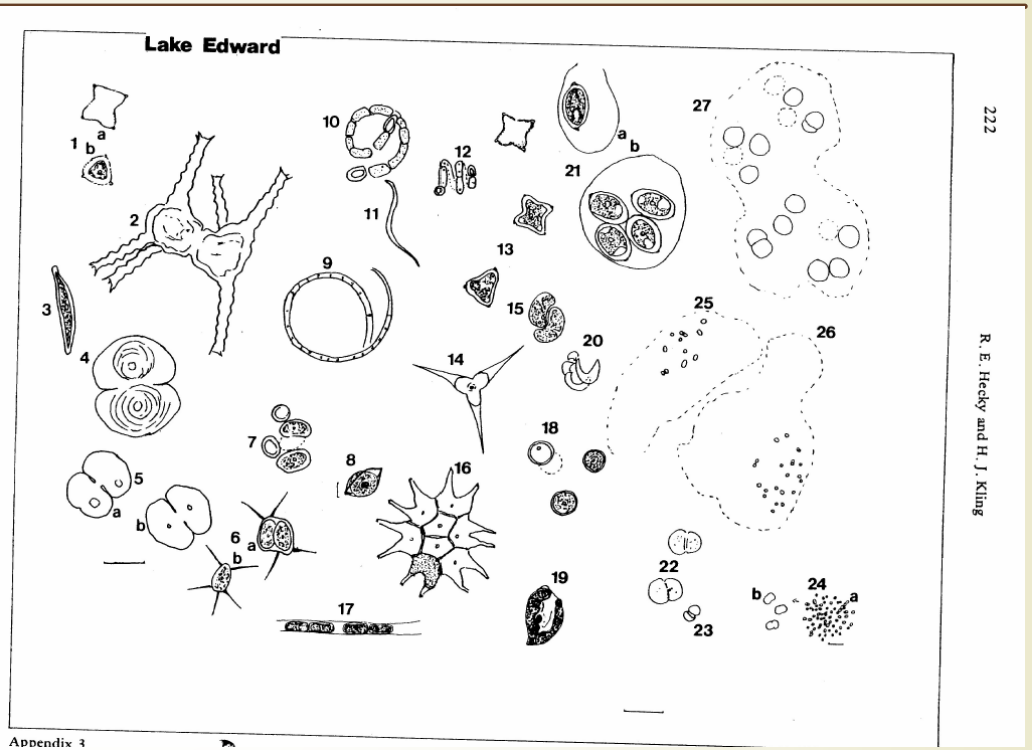


Fig. 7. Horizontal distribution of phytoplankton abundance and composition in Lakes Kivu, Edward and Albert in March 1972.



Hecky & Kling (1972):
dominated by green and blue-green algae.
However, few net samples were taken, and only near the southern part of the lake.

Phytoplankton composition: historical data

Hence, only qualitative data from the Damas expedition (1936-1937) are available for comparison.

Exploration du Parc National Albert

MISSION H. DAMAS (1935-1936)

FASCICULE 8

Exploratie van het Nationaal Albert Park

ZENDING H. DAMAS (1935-1936)

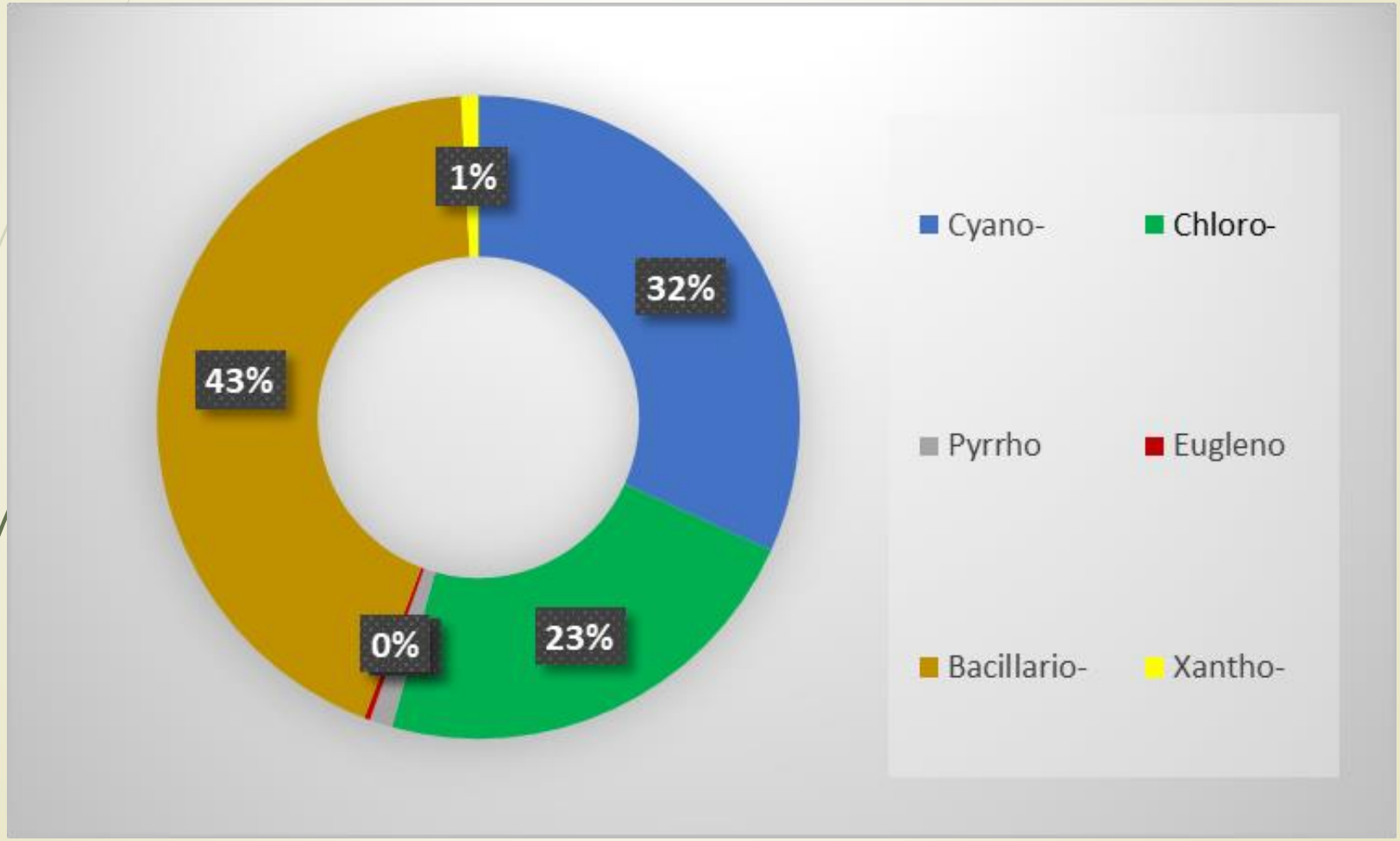
AFLEVERING 8

SÜSSWASSER-DIATOMEEN

VON

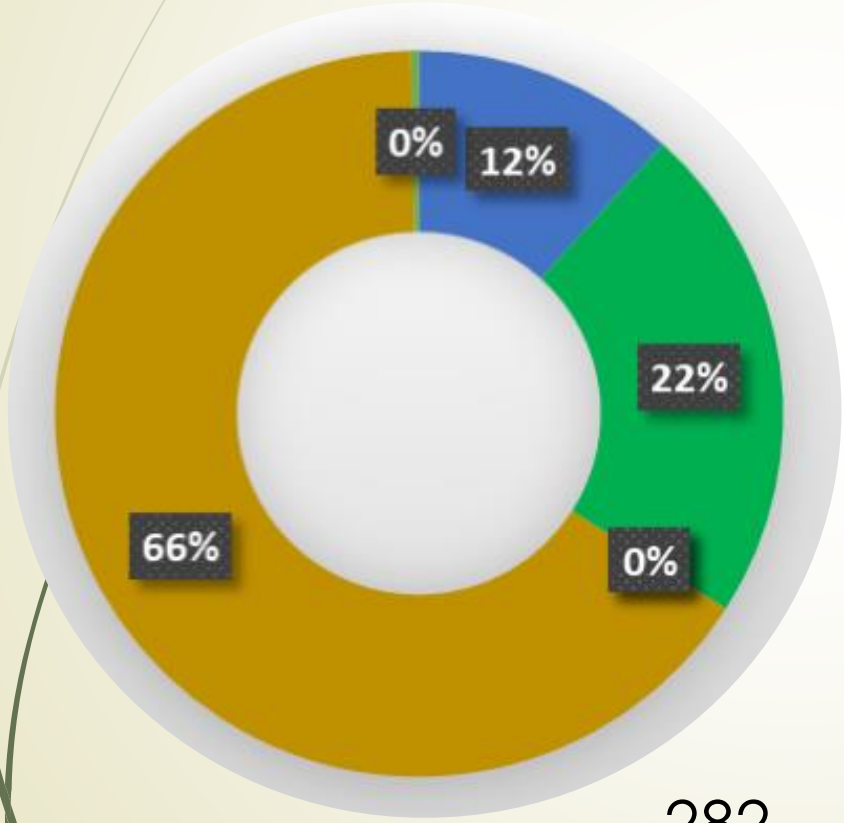
FRIEDRICH HUSTEDT (Plön, Holstein)

Microscopic processing of L. Edward phytoplankton – 346 taxa



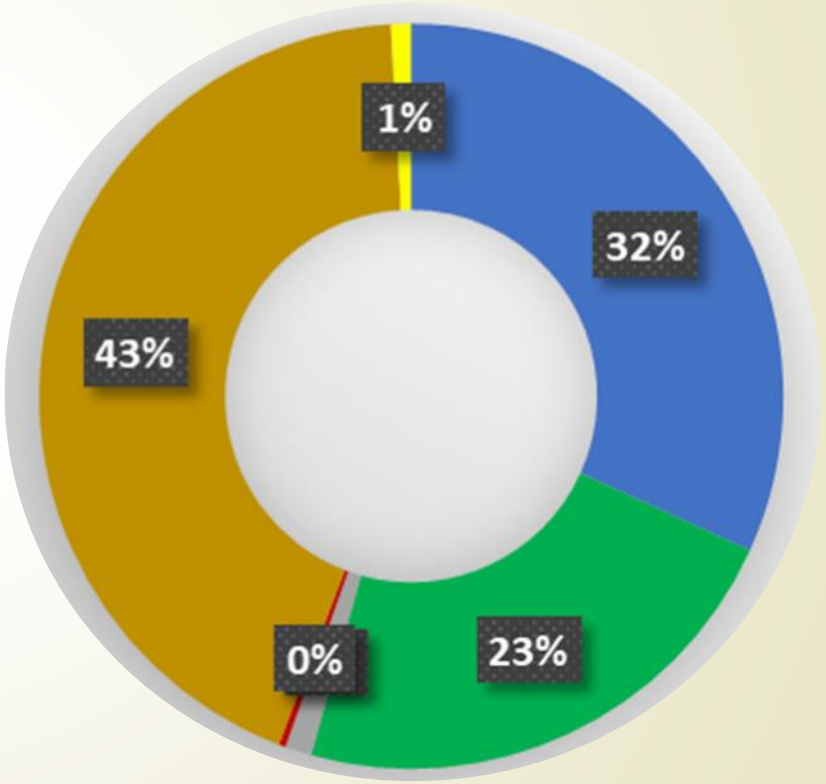
Comparison of data on L. Edward phytoplankton

1935-1936



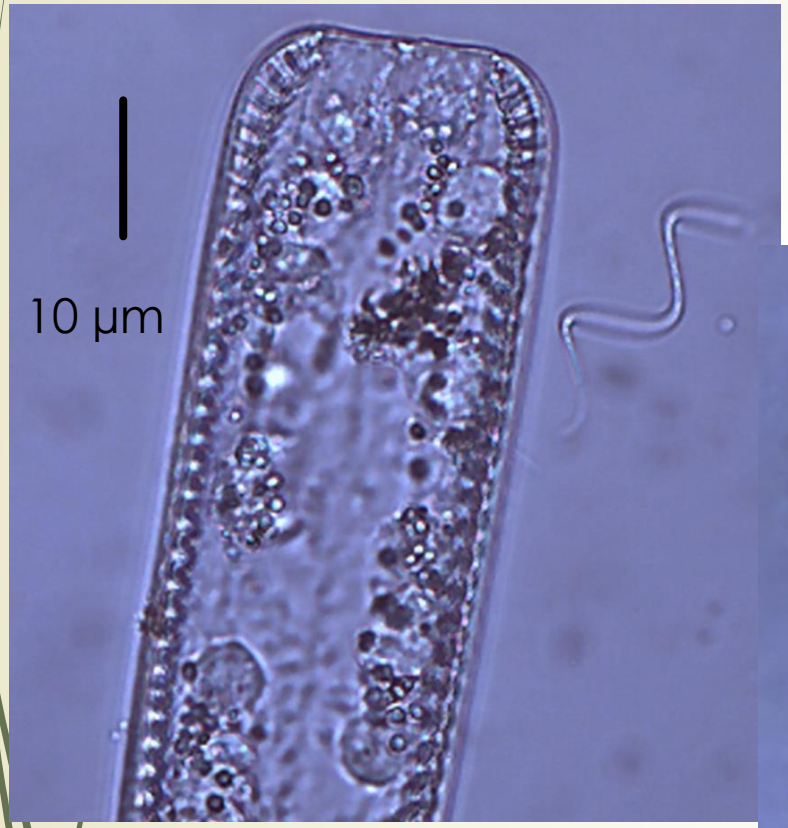
282

2016-2017

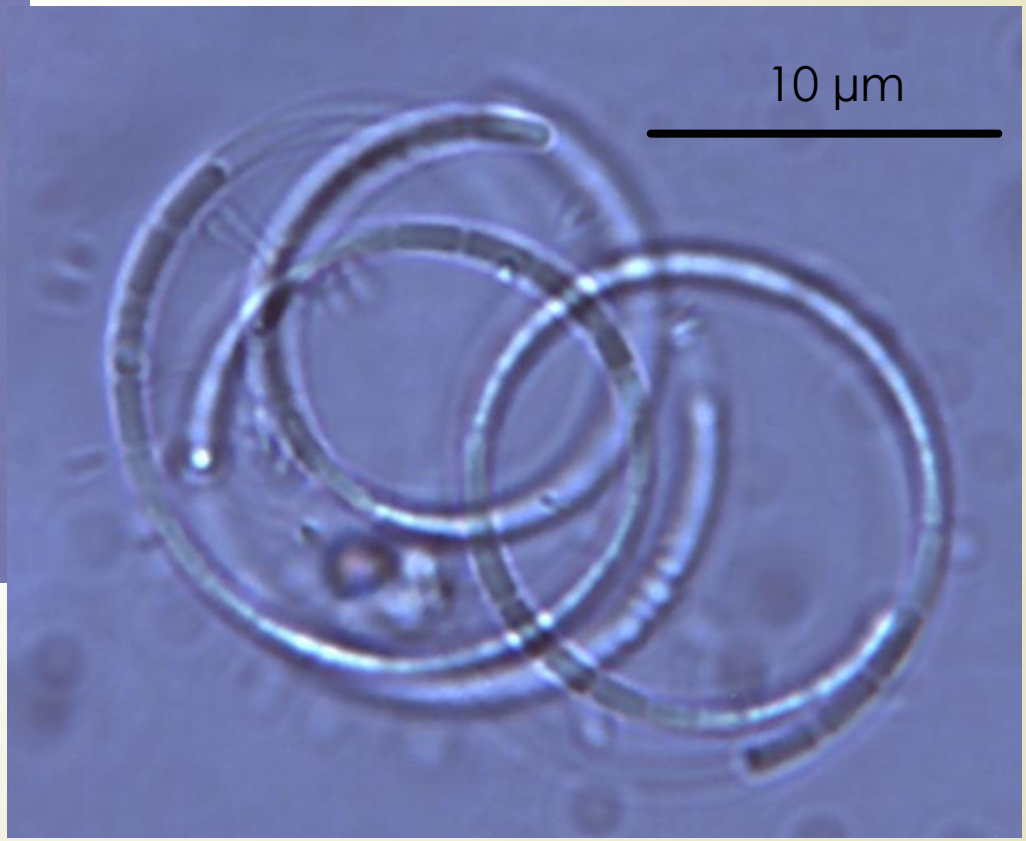


346

L. Edward phytoplankton – key groups



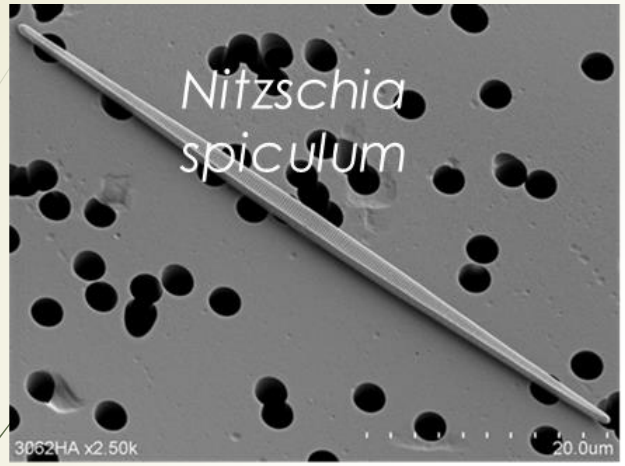
Core of tropical species

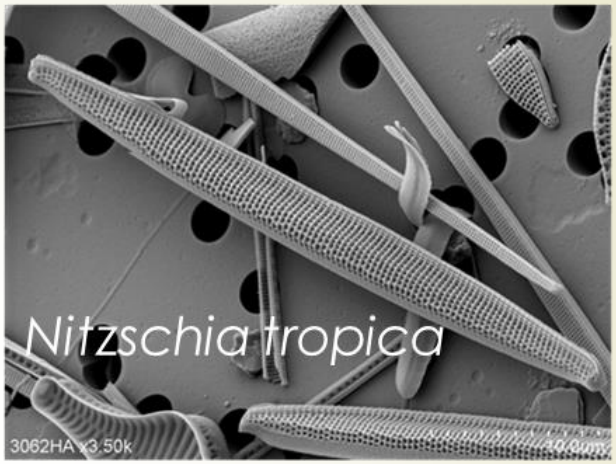


L. Edward phytoplankton – key groups

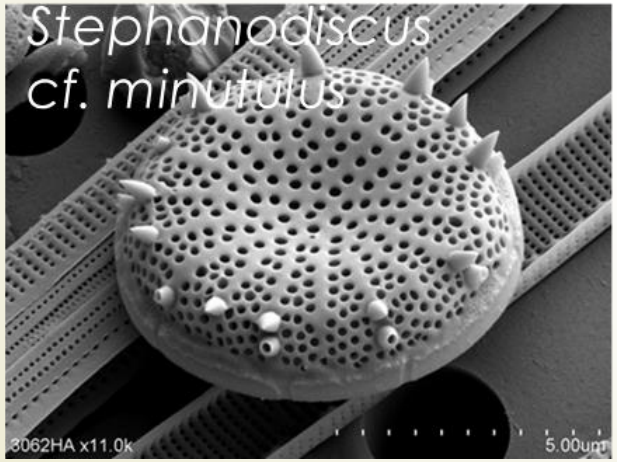
L. Edward phytoplankton – characteristic taxa

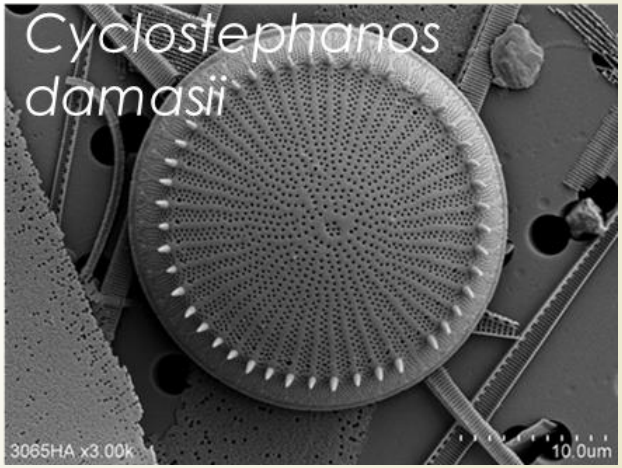
Diatoms





Pennate





Centric

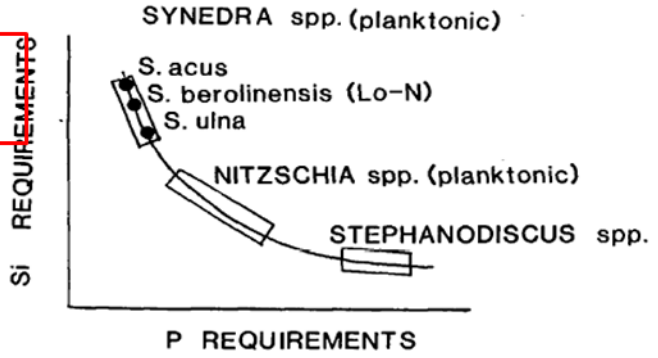
SEM photos thanks to L. Ector and C. Wetzel (LIST, Luxembourg)

What diatoms tell?

The abundance of « needle-like » *Nitzschia* (shown also by Hustedt 1949) may indicate low P availability

Kilham et al. 1989

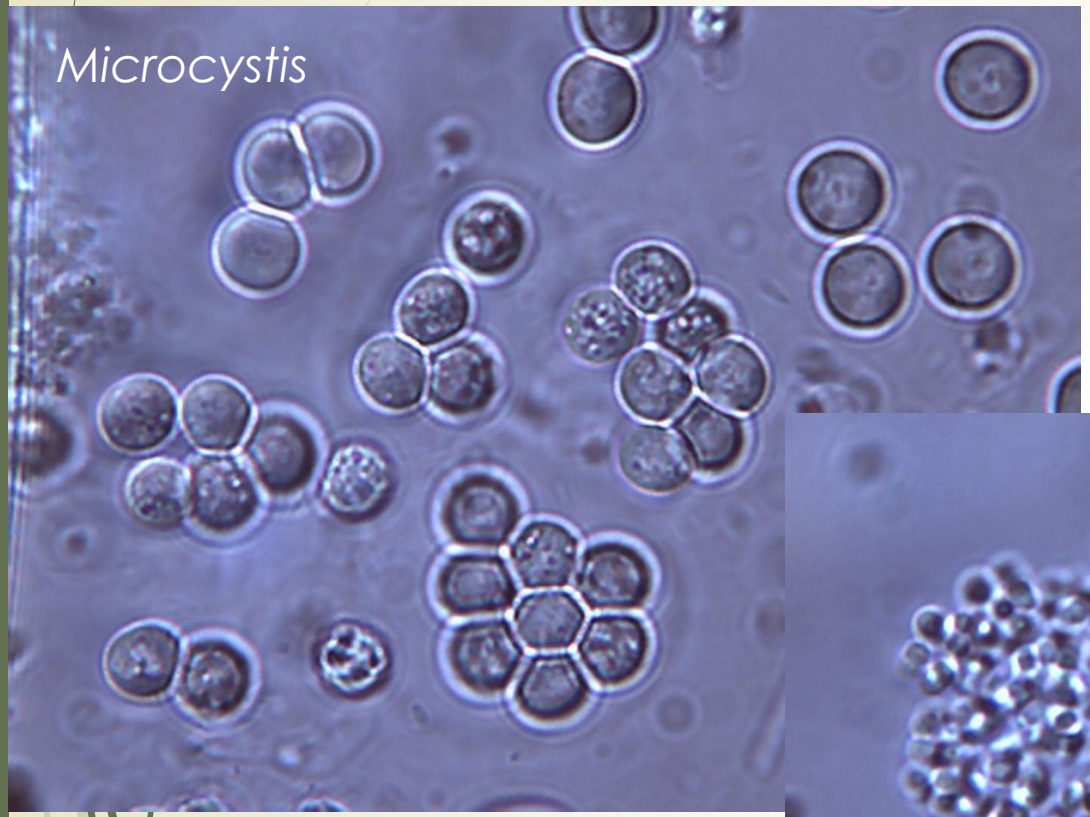
terns very similar to those of *A. formosa* (Stoermer et al. 1975). We hypothesize that the long, needlelike *Nitzschia* species have fairly high optimal Si:P ratios and fill a niche in tropical lakes similar to that of *A. formosa* and *F. crotonensis* in temperate lakes. It is probable that these latter two species are restricted to lakes with temperatures generally below 20°C (Tilman et al. 1981). *Asterionella formosa* has been reported in Africa in lakes with temperatures below 20°C at elevations above 3,000 m (Hustedt 1949).



Possible long-term change of composition in L. Edward?
Needs confirmation based on fossil (sediment) diatoms

L. Edward phytoplankton – characteristic taxa

Cyanoprokaryota/Cyanobacteria



Coccal cyanos

L. Edward phytoplankton – characteristic taxa

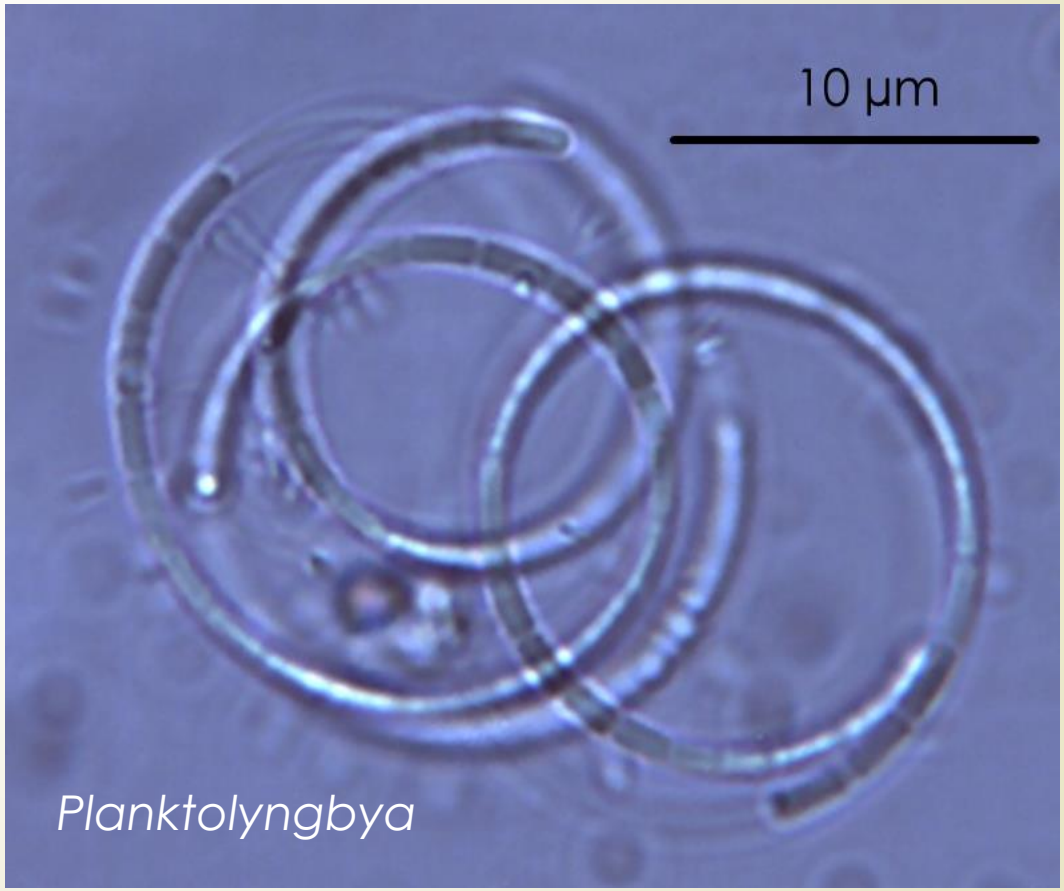
Cyanoprokaryota/Cyanobacteria

Filamentous heterocytous cyanos – N-fixation

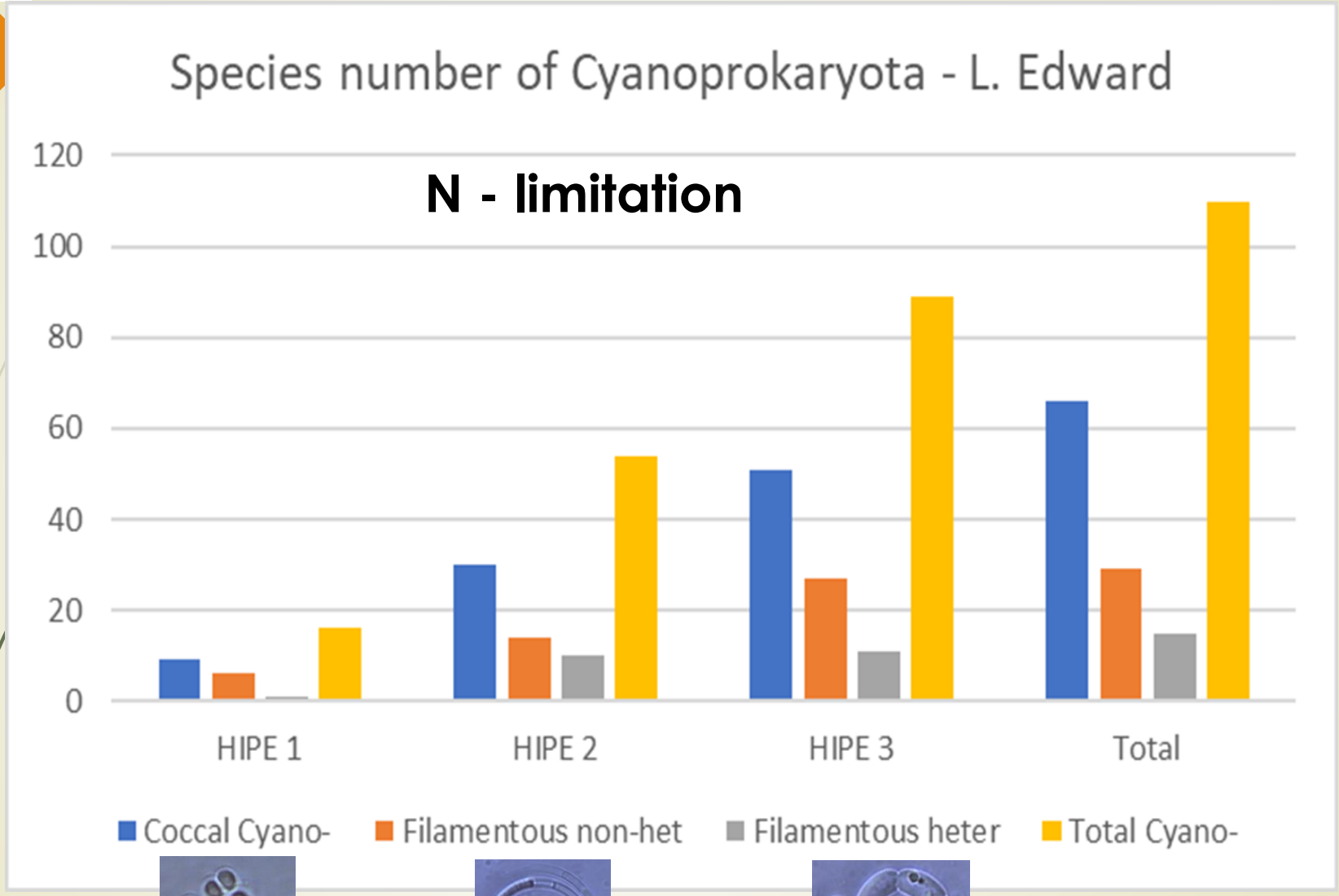
L. Edward phytoplankton – characteristic taxa

Cyanoprokaryota/Cyanobacteria

Filamentous non-heterocytous cyanos

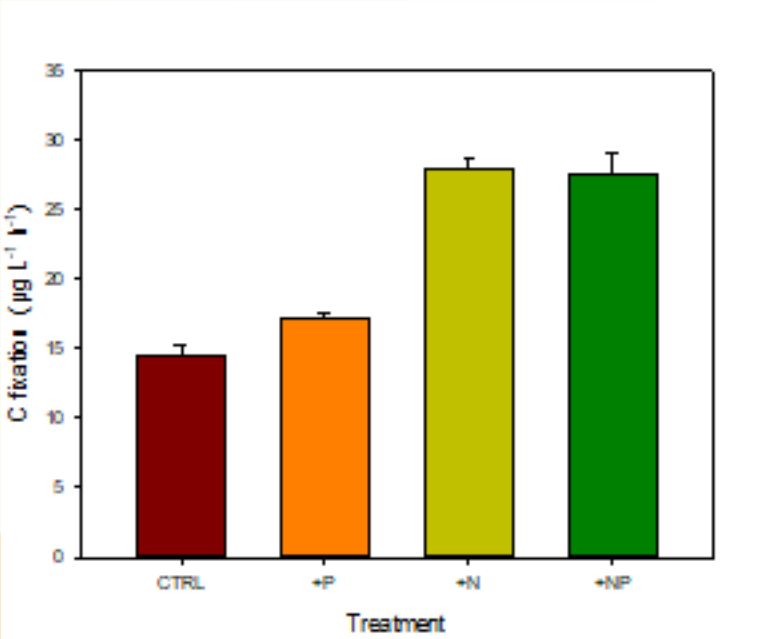


What these three groups show?



Phytoplankton

Nutrient limitation: **mean POC : PN ratio ~9,7 (+- 1.7)** indicates moderate N limitation

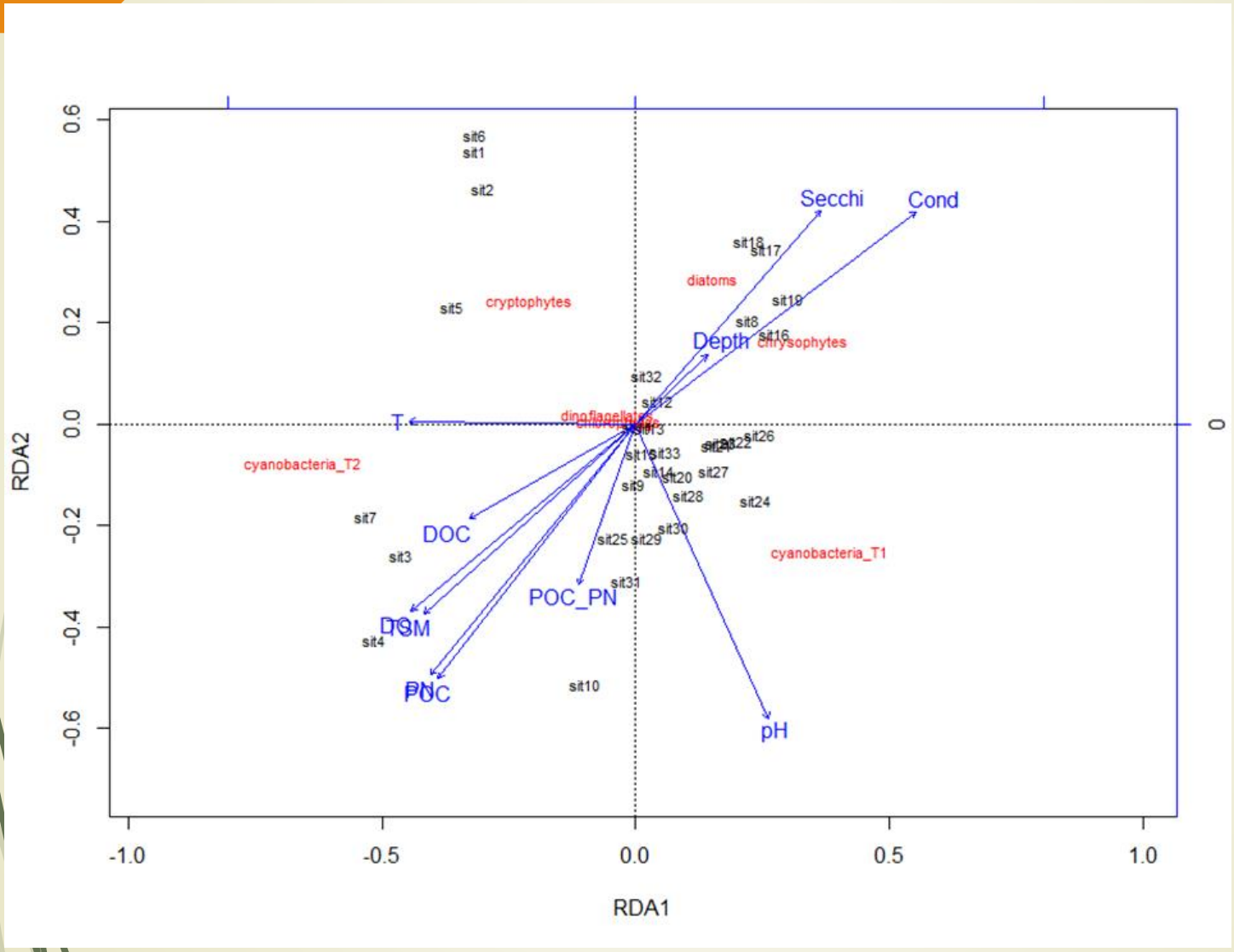


Photosynthetic C fixation rates measured during a nutrient limitation experiment (24h incubation under constant light irradiance) carried out with samples from a pelagic station in L. Edward (20m max depth).

N limitation of photosynthetic C fixation confirmed for pelagic sites.

N_2 fixation experiments showed that the process is active in the lake, and takes places in the light, suggesting a main contribution by heterocytous cyanobacteria.

RDA on phytoplankton groups vs. environmental variables



High C:N ratio and high pH may be key variables driving cyano-dominance

Conclusions from phytoplankton data

1. General composition : dominance by cyanoprokaryotes/cyanobacteria and diatoms whatever the water column conditions;

2. Higher diversity than previously reported;

3. Analysis of currently available data suggests that N limitation occurs at all times and may be a key driver explaining the success of cyanobacteria, along with light limitation and high pH;

4. Possible long-term change of composition in L. Edward? Yes, the abundance of « needle-like » *Nitzschia* may indicate low P availability, but this needs to be confirmed based on fossil (sediment) diatoms.

THANK YOU FOR THE ATTENTION