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

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HIPE

HUMAN IMPACTS ON ECOSYSTEM HEALTH AND RESOURCES OF LAKE EDWARD

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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)

Precipitation (mm yr\(^{-1}\))

\[ r^2 = 0.36 \]

\[ r^2 = 0.34 \]
Weekly cumulated precipitation (mm)
Weekly averaged wind speed (m s\(^{-1}\))

Cruises
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

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Historical data on L. Edward phytoplankton
Mission H. Damas (1935-36)

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Albert</th>
<th>Edward</th>
<th>Kivu</th>
<th>Rukwa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanobacteria</td>
<td>6</td>
<td>33</td>
<td>15</td>
<td>4</td>
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<tr>
<td>Chlorophyta</td>
<td>24</td>
<td>63</td>
<td>17</td>
<td>7</td>
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<tr>
<td>Xanthophyta</td>
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<td></td>
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<tr>
<td>Bacillariophyta</td>
<td>14</td>
<td>185</td>
<td>132</td>
<td>76</td>
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<tr>
<td>Dinophyta</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euglenophyta</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48</td>
<td>282</td>
<td>164</td>
<td>87</td>
</tr>
</tbody>
</table>

* 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

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.
Microscopic processing of L. Edward phytoplankton – 346 taxa
Comparison of data on L. Edward phytoplankton

1935-1936

- 66% (282)
- 0% (12%)
- 0% (22%)

2016-2017

- 32% (346)
- 43% (0%)
- 23% (1%)
L. Edward phytoplankton – key groups

Core of tropical species
L. Edward phytoplankton – key groups
L. Edward phytoplankton – characteristic taxa

Diatoms

*Nitzschia spiculum*

*Nitzschia turgida*

*Stephanodiscus cf. minutulus*

*Cyclostephanos damasii*

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

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What diatoms tell?

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

Kilham et al. 1989

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

Cyanoprokaryota/Cyanobacteria

Microcystis

Coccal cyanos

Coelomorun
L. Edward phytoplankton – characteristic taxa

Cyanoprokaryota/Cyanobacteria

Anabaenopsis

Filamentous heterocytous cyanos – N-fixation

Raphidiopsis
Syn. Cylindrospermopsis
L. Edward phytoplankton – characteristic taxa

Cyanoprokaryota/Cyanobacteria

Romeria

Filamentous non-heterocytous cyanos

Pseudanabaena

Planktolyngbya

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What these three groups show?

Species number of Cyanoprokaryota - L. Edward

N - limitation

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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 cyanobacteria 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