Facultés des Sciences
Département de Biologie

Unité de Recherche en Biologie des Organismes

F U N D P Namur

Our present understanding of Lake Kivu Ecology

A team work … (1/3)

FUNDP:

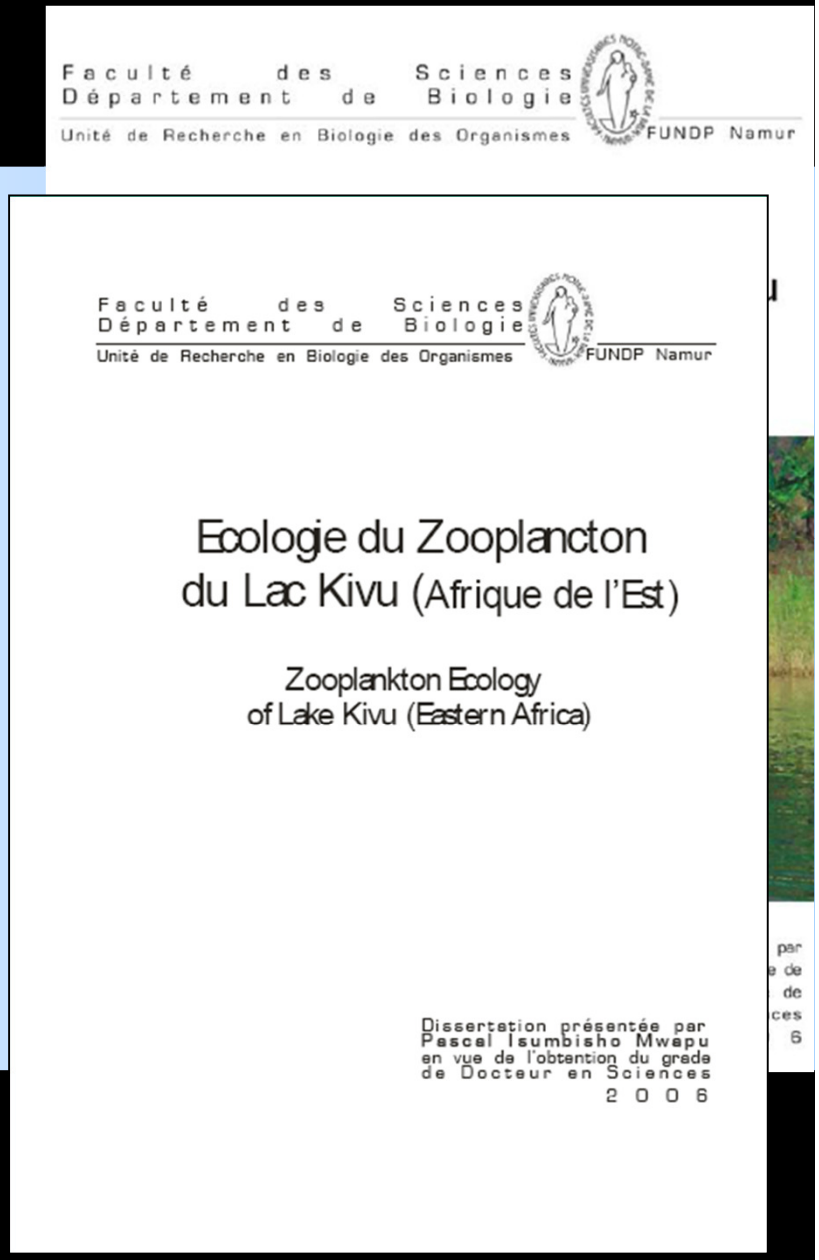
Hugo Sarmento, PhD (2002 - 2006)

Pascal Mwapu Isumbisho,
PhD (2002 - 2006)

Pascal Masylia (2006 - …)

Nathalie Homblette (2007 - …)

Christophe Leblanc (UCL/FUNDP)
(2007-…)



A team work … (2/3)

The ECOSYKI project (2004-2009):
a research and cooperative project granted by the CUD

FUNDP: Prof. Jean-Pierre Descy, *et alii*

UCL: Prof. Eric Deleersnijder, *et alii*

ISP-Bukavu: Prof. Pascal Mwapu Isumbisho, *et alii*

UNR-Butare: Prof. Laetitia Nyina-wamwiza, *et alii*

INRA-Thonon: Prof. Jean Guillard

A team work … (3/3)

The CAKI project (2007-2010):

fundamental research project on Lake Kivu carbon and nutrient cycles granted by the FNRS

ULg: Alberto Borges, *et alii*.

ULB: Pierre Servais

FUNDP: François Darchambeau, *et alii*.

A team work … (3/3)

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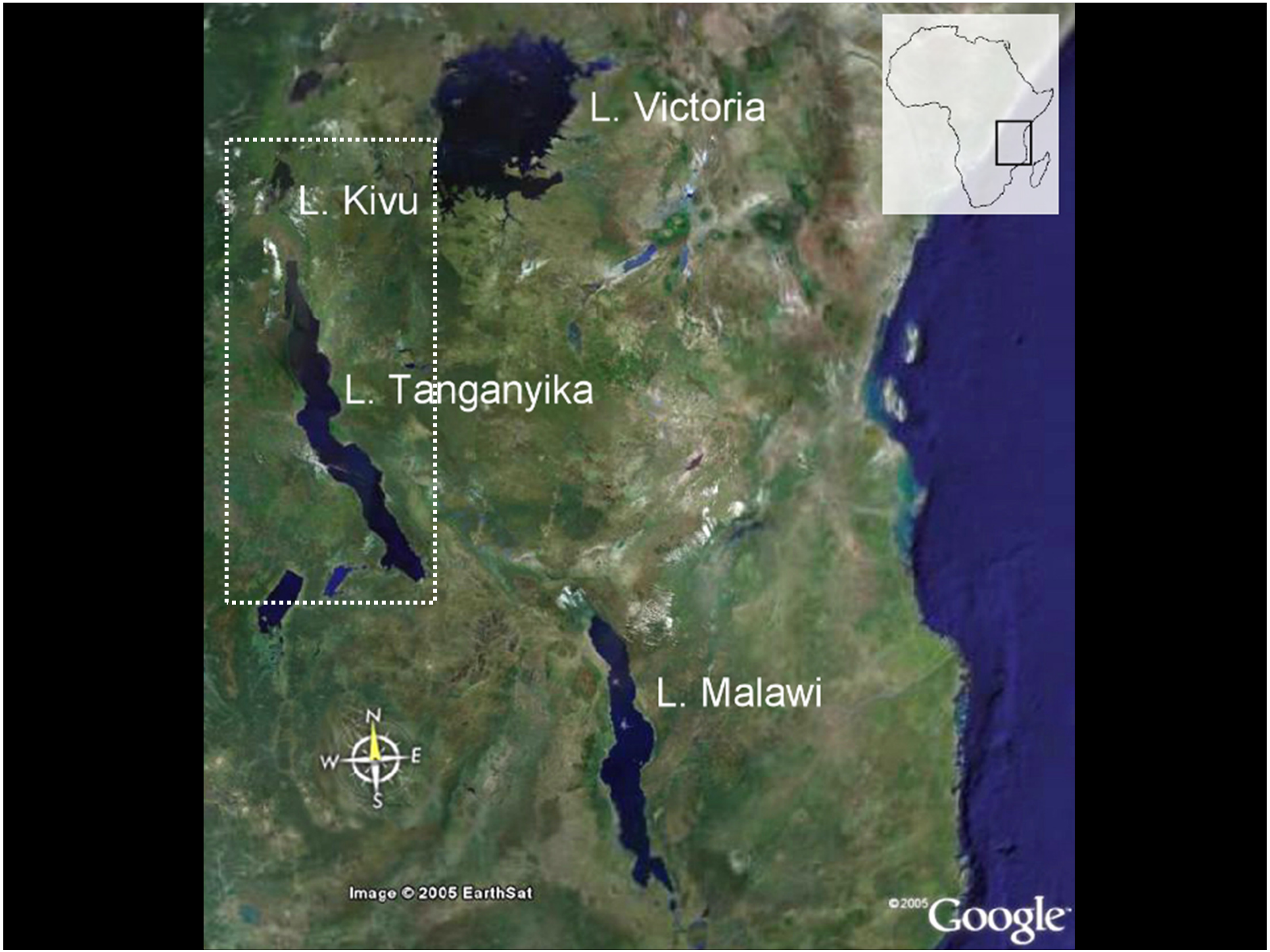
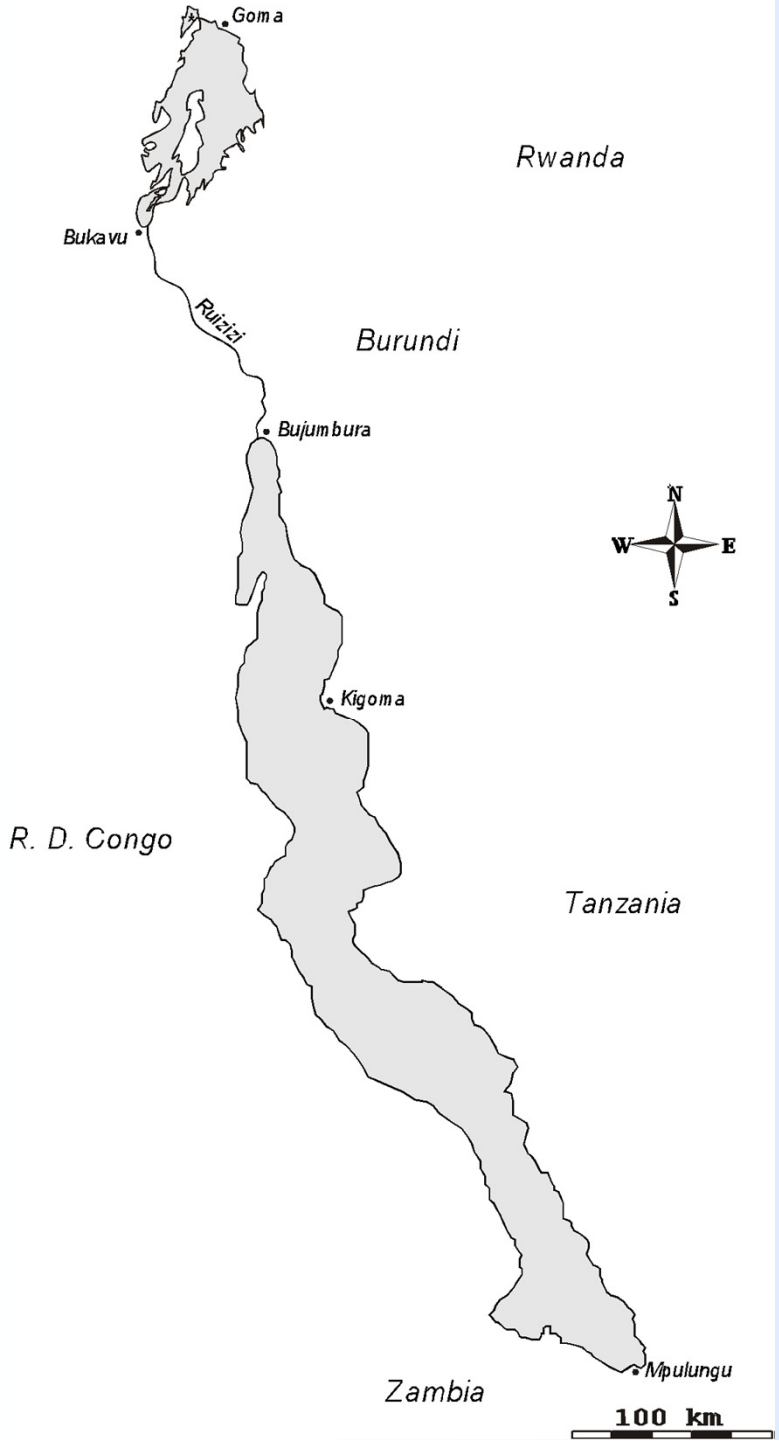
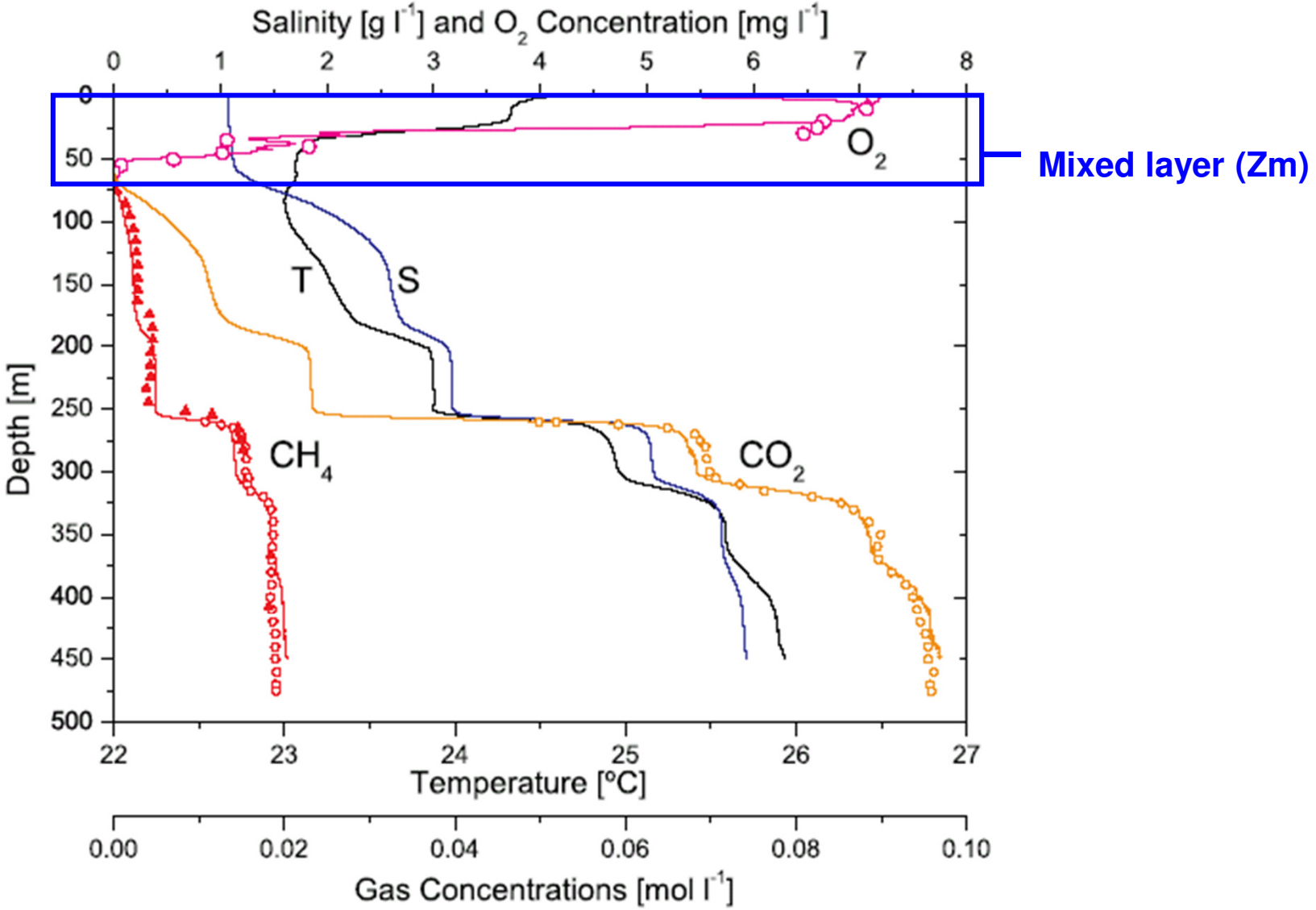

L. Victoria
L. Kivu
L. Tanganyika
L. Malawi
N
W
E
S
Image © 2005 EarthSat
©2005 Google



	Lake Kivu	Lake Tanganyika
Altitude	1460 m asl	800 m asl
Max. dimensions	100 x 50 km	650 x 60 km
Surface	approx. 2 370 Km^2	approx. 32 600 Km^2
Volume	approx. 650 Km^3	approx. 18 940 Km^3
Max depth	490 m	1470 m
Mean Chl *a*	2,2 µg L^{-1}	0,7 µg L^{-1}
Mean Z_{eu}	20 m	40 m

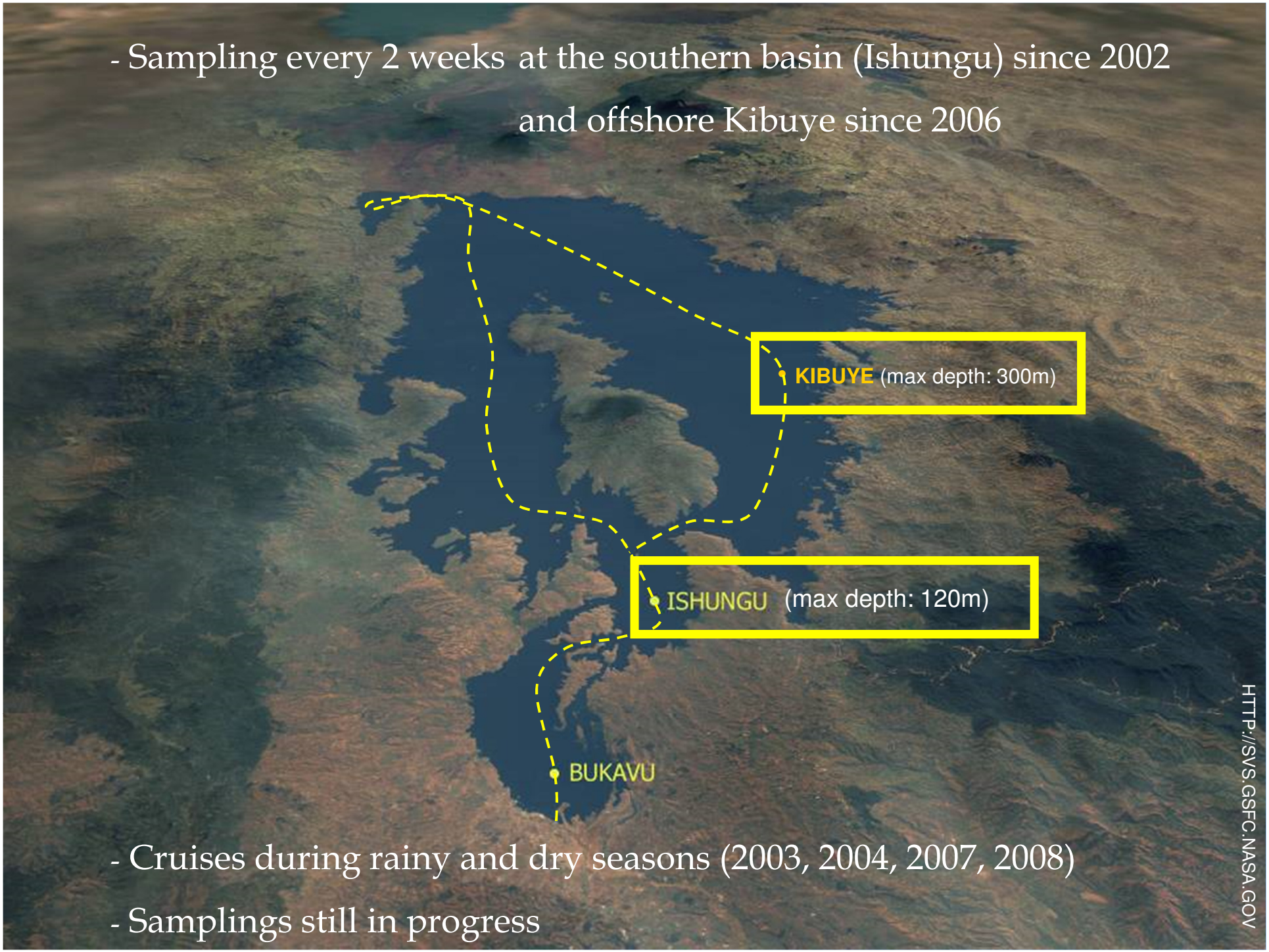
Both:	Oligotrophic
	Meromictic
	Rainy season (October - May)
	Dry season SE winds (June – September)



G3 - Geochemistry Geophysics Geosystems, Schmid *et al.*, 2005

- Sampling every 2 weeks at the southern basin (Ishungu) since 2002

and offshore Kibuye since 2006



- Cruises during rainy and dry seasons (2003, 2004, 2007, 2008)

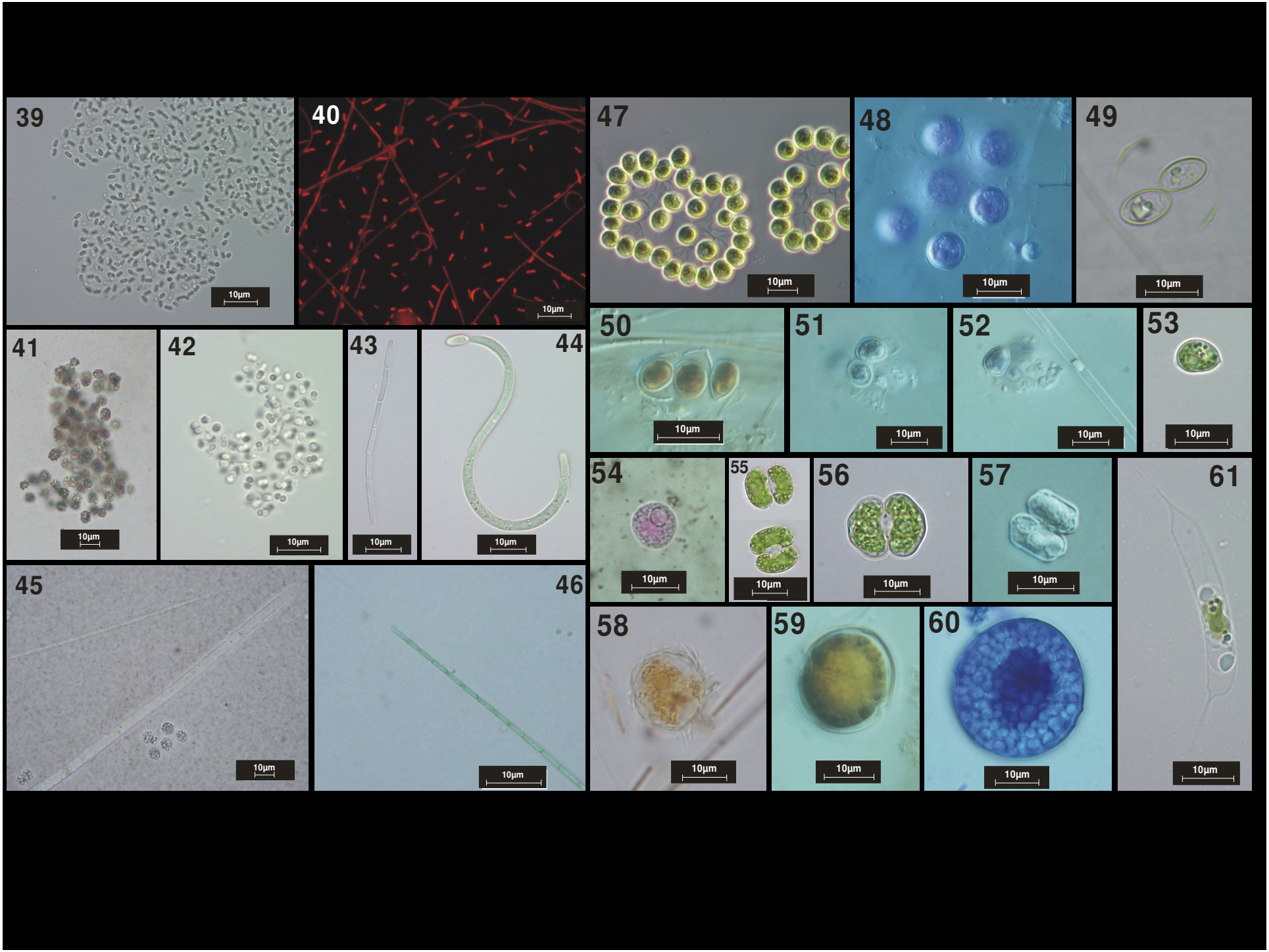
- Samplings still in progress

Phytoplankton & Zooplankton

Phytoplankton & Zooplankton

Damas (1937), about the pelagic plankton of Lake Kivu:

"Ses eaux claires et transparentes sont un véritable désert".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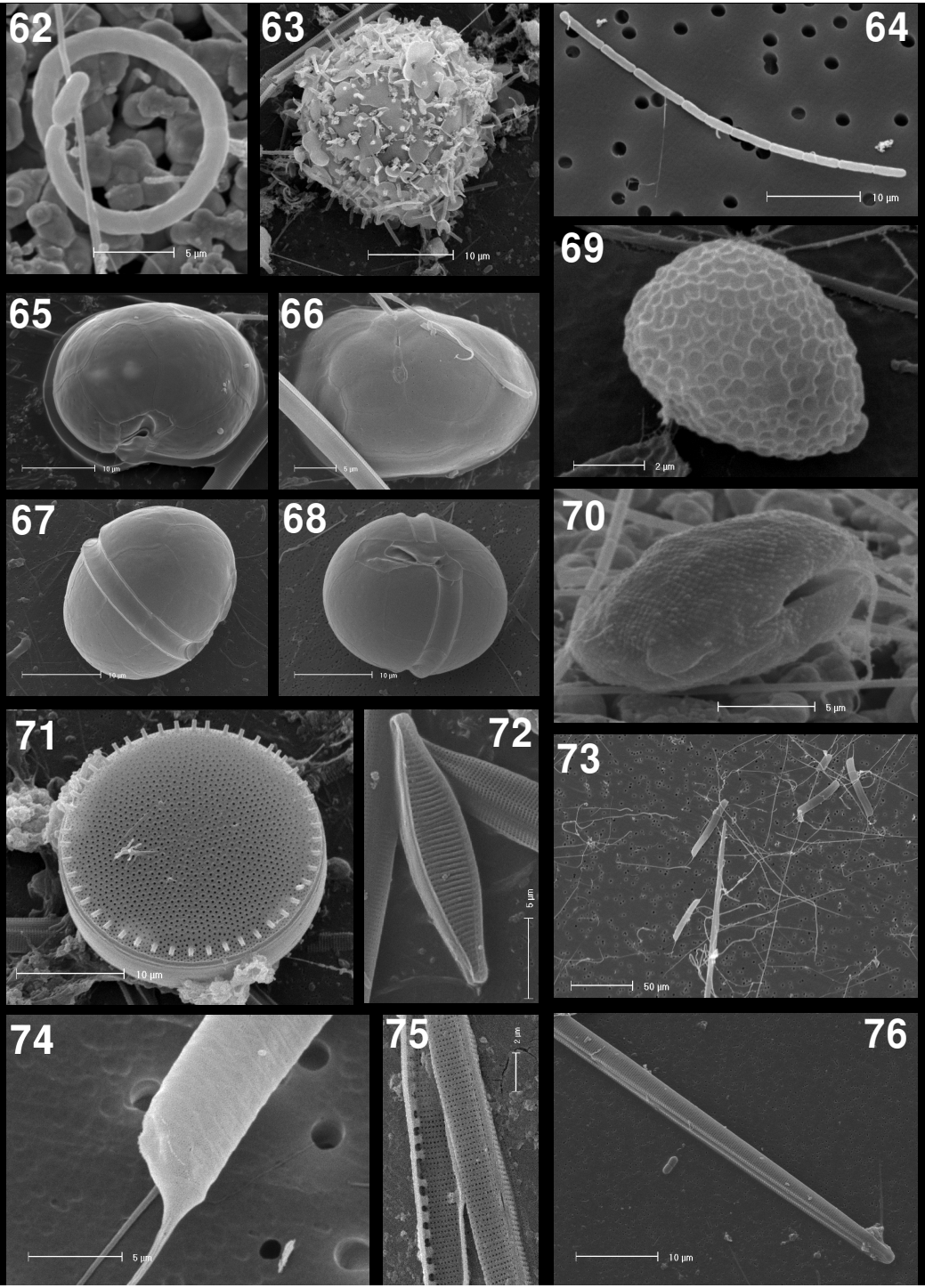


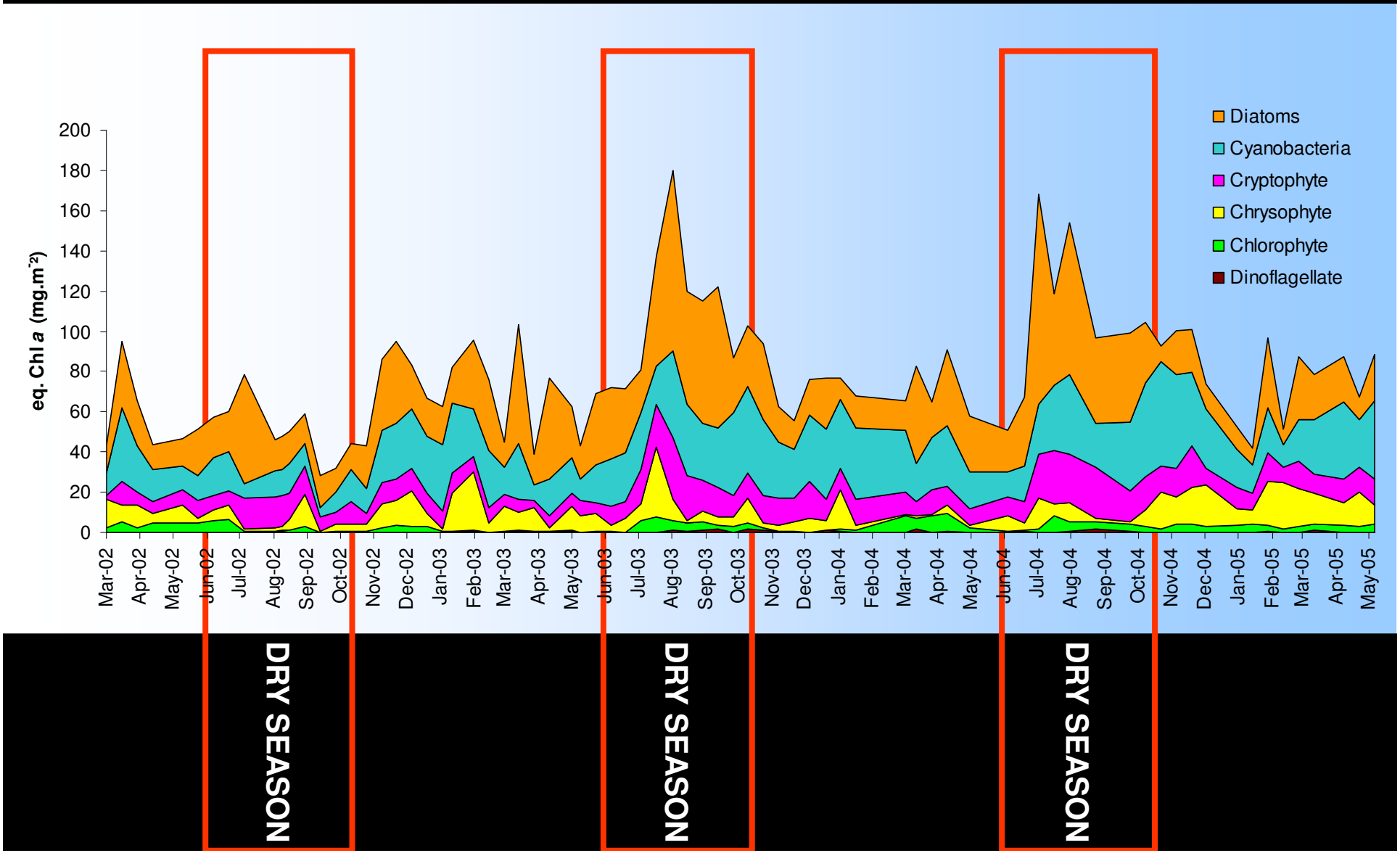
A total of 42 taxa was recorded:

- 14 Cyanophyceae
- 3 Cryptophyceae
- 3 Dinophyceae
- 7 Bacillariophyceae
- 1 Chrysophyceae
- 7 Chlorophyceae
- 3 Trebouxiophyceae
- 4 Zygnematophyceae

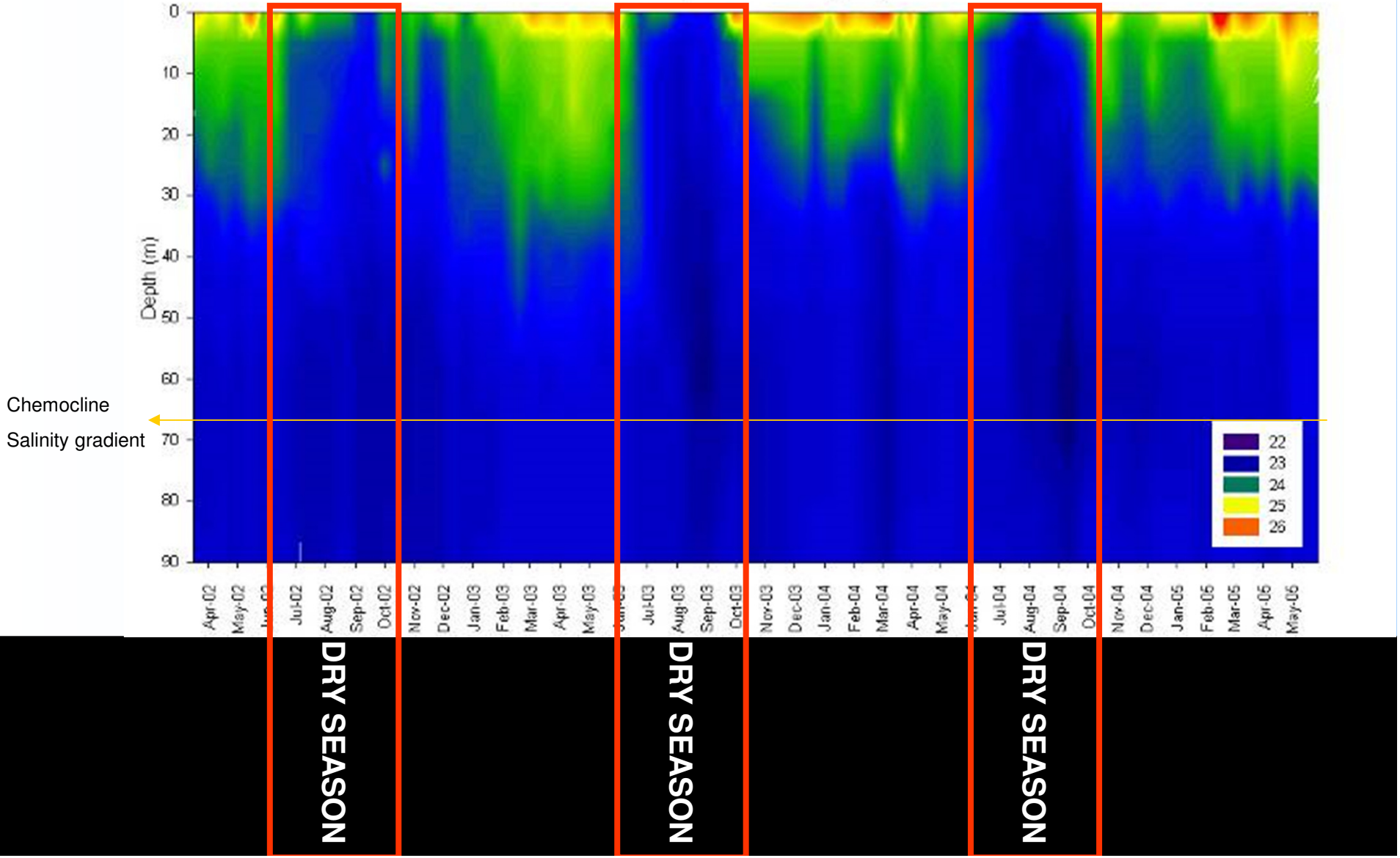
Limited changes were apparent in comparison with the situation described in 1937 after the first Belgian expeditions;

… But diatoms seem more abundant now than in the 70's…

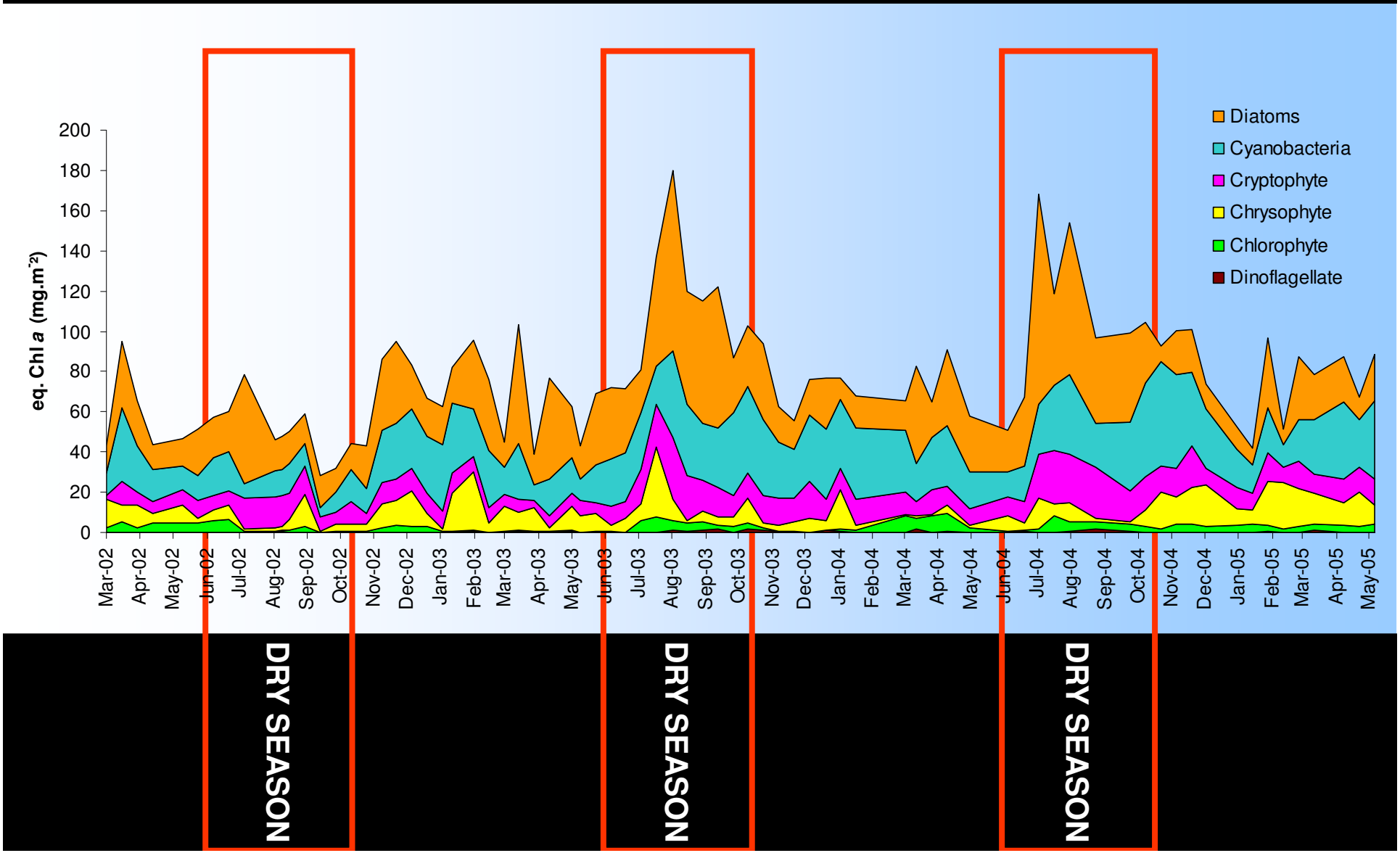
Phytoplankton biomass & composition



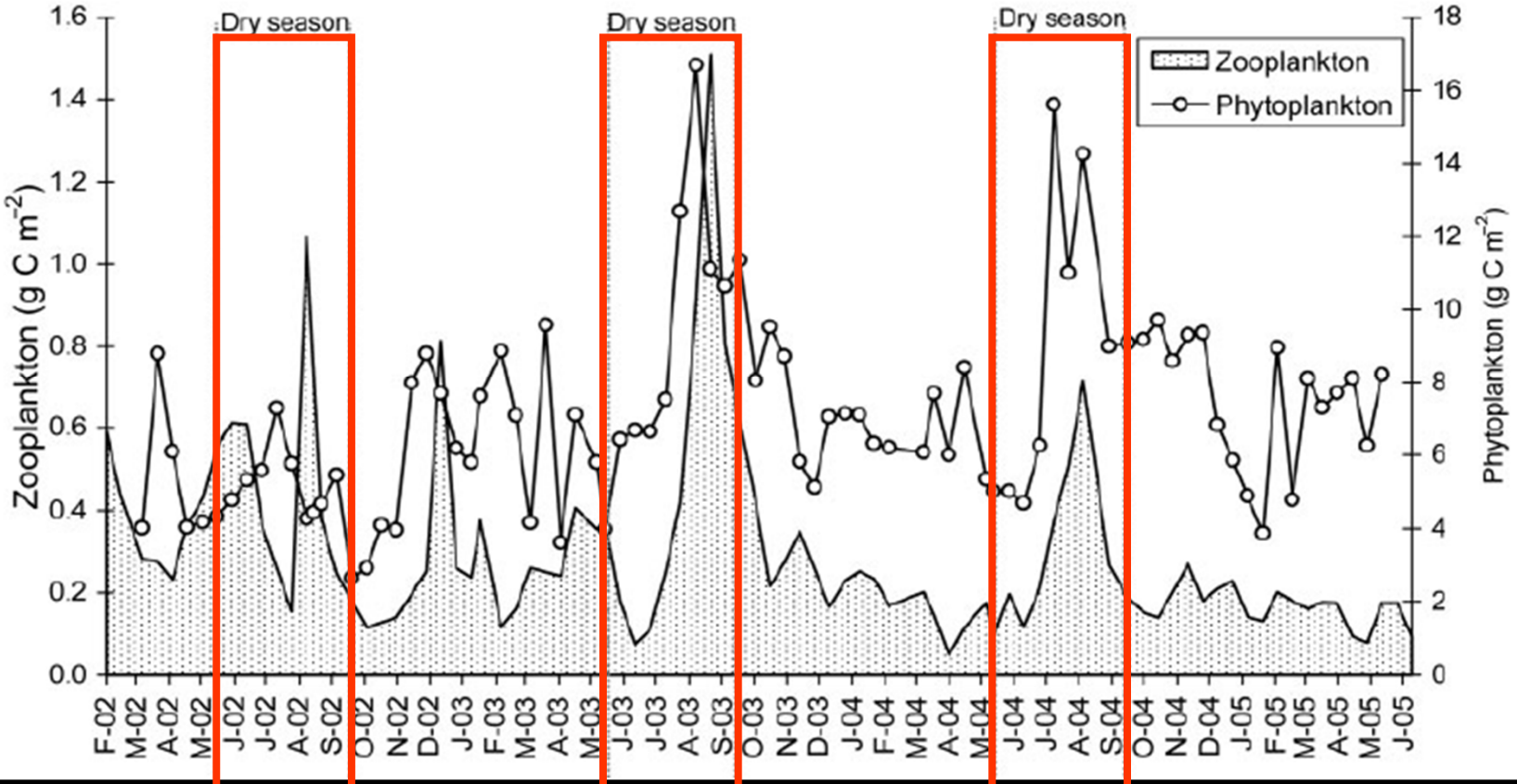
Temperature



Phytoplankton biomass & composition



Phytoplankton and zooplankton blooms



DRY SEASON

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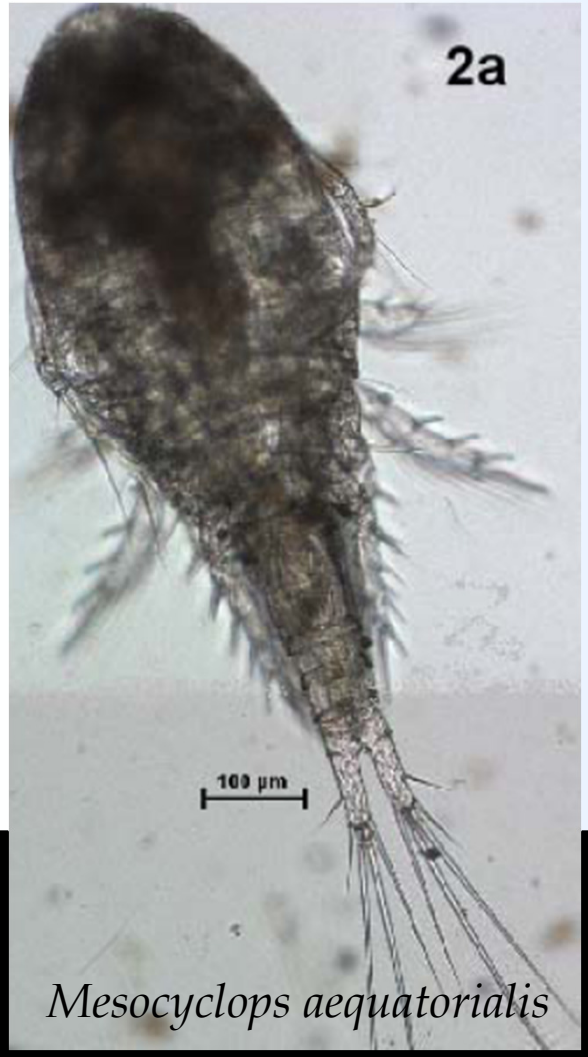
Zooplankton composition



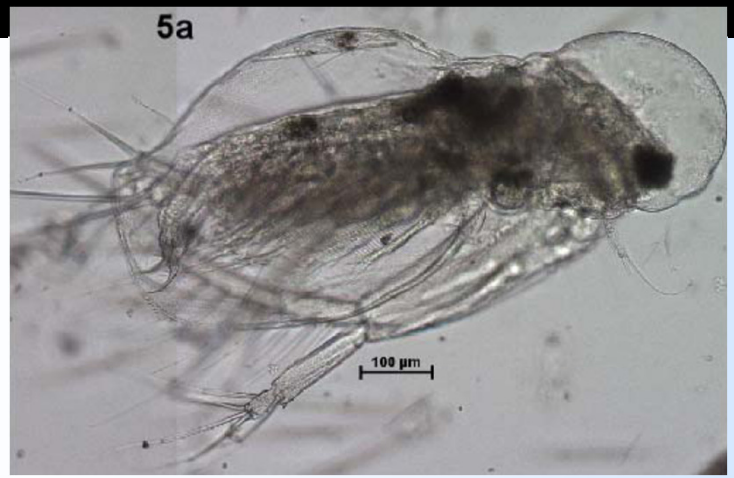
Mesocyclops aequatorialis

Thermocyclops consimilis

Tropocyclops confinis

Cyclopoid copepods

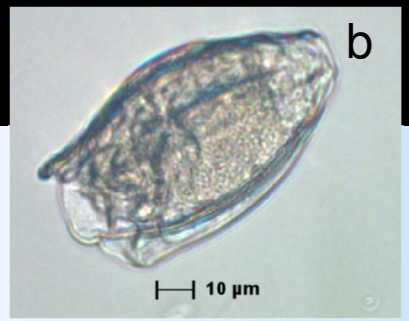
Zooplankton composition

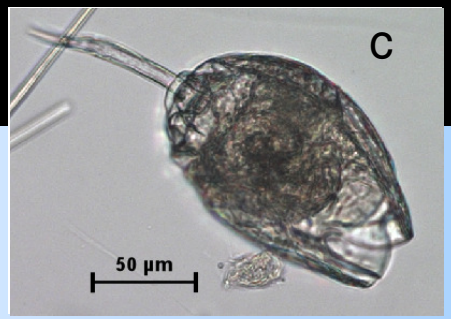


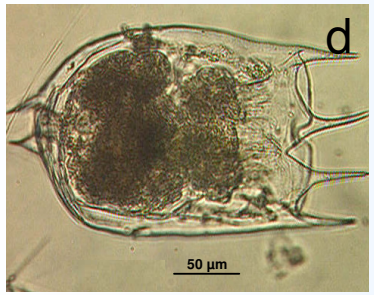
Cladocerans

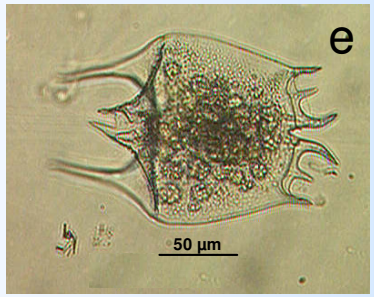
a: *Diaphanosoma excisum* b: *Alona rectangula* c: *Ceriodaphnia cornuta* d: *Moina micrura*

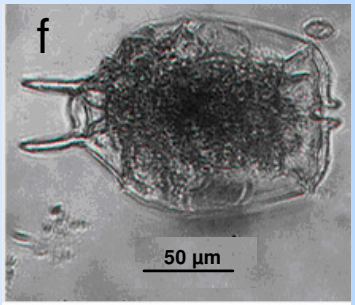
Zooplankton composition

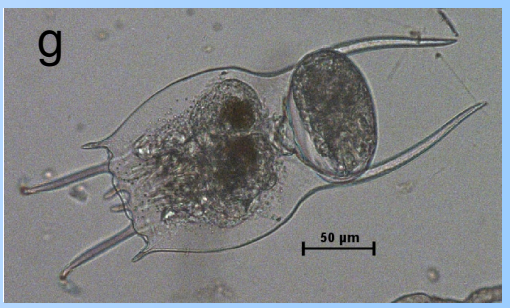


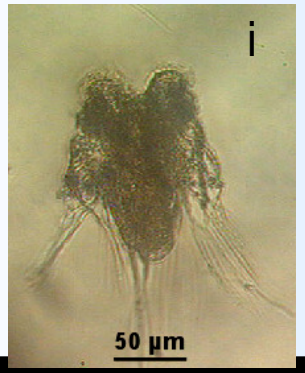


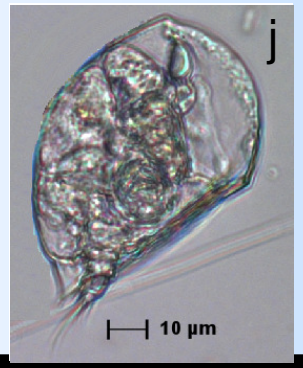


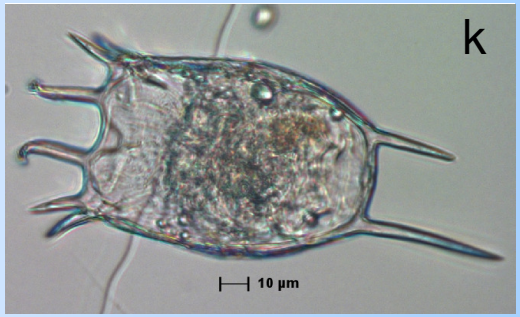












a: Bdelloid b: *Anuraepsis fissa* c: *Lecane* sp. d: *Brachionus calyciflorus* e: *Brachionus quadridentatus*
f: *Brachionus caudatus* g: *Brachionus falcatus* h: *Polyarthra* sp. i: *Hexarthra* sp. j: *Collurella* sp.
k: *Keratella tropica*

Rotifers

Primary production

Period	PP $gC.m^{-2}.d^{-1}$	n	Reference
March 1972	1.03 – 1.44	<14	Degens *et al.*, 1973
March 1972 – 73	0.66 – 1.03	8	Jannasch, 1975
October 1990	0.33	3	Descy, 1990
2002 – 2008	0.64 (0.19 – 1.18)	55	present study

No detectable variations of PP during the last 35 years

Primary production

Lake	Period	Mean PP $gC.m^{-2}.y^{-1}$	Reference
L. Kivu	2003-2008	232	present study
L. Tanganyika	2002-2003	159	Stenuite *et al.*, 2007
L. Malawi	90's	169	Guildford *et al.*, 2007
L. Victoria	2001-2002	1061	Silsbe 2004

An oligotrophic lake but with higher biomass than L. Tanganyika and Malawi

Zooplankton biomass & production

Lake	Mean biomass $gC.m^{-2}$	Mean annual production $gC.m^{-2}.y^{-1}$	Reference
L. Tanganyika	1.2	23	Kurki e*t al.*, 1999; Sarvala *et al.*, 1999
L. Malawi	0.9	24.5	Irvine, 1995; Irvine & Waya, 1999
L. Kivu	0.3	8.3	present study

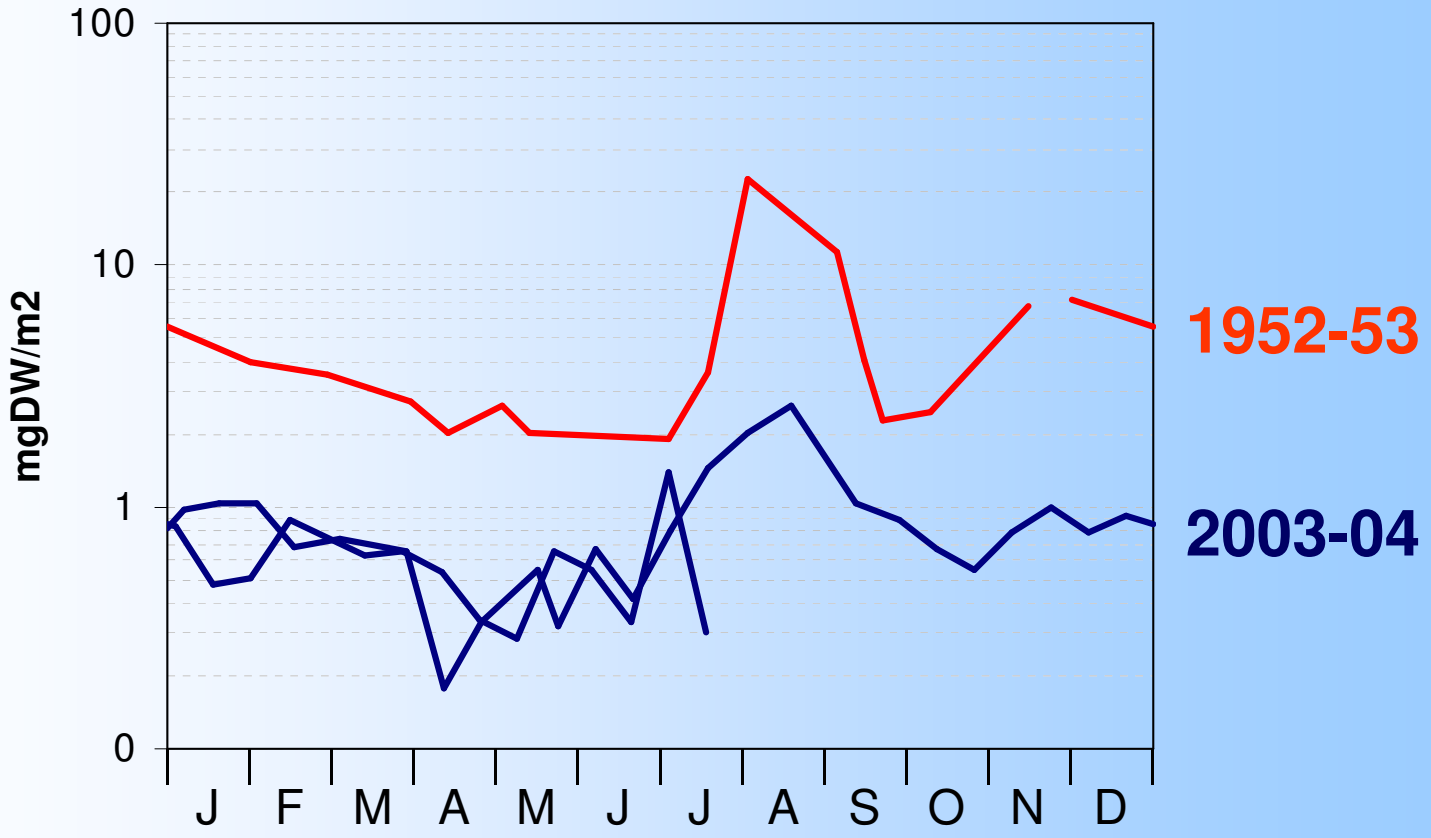
Very low secondary production …

Zooplankton biomass & production

Lake	Trophic transfer efficiency %	Reference
African lakes	10.1	Pauly & Christensen, 1995
L. Tanganyika	3.5 – 5.4	Sarvala *et al.*, 1999
L. Malawi	5 – 8	Irvine & Waya, 1999
L. Kivu	1.3 – 2.1	present study

… and concomitant low trophic transfer efficiency

Zooplankton biomass & production



Important decrease of zooplankton biomass since …

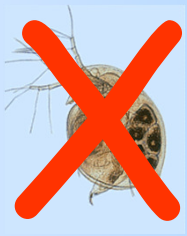
In the 20th and 21st centuries…

- **Verbeke (1952-1954): study of zooplankton, no planktivore in the pelagic waters**

- **Introduction of *Limnothrissa miodon* in the late 50s**

- ***Success of the introduction of the freshwater Clupeid Limnothrissa miodon in Lake Kivu* (*Fish Farming International,* Frank, 1977 ; *Fisheries Management*, Spliethoff *et al.,* 1983)**

- ***The Tanganyika sardine in Lake Kivu: Another ecodisaster for Africa?***
(*Environment Conservation*, Dumont 1986)



… Limnothrissa *introduction*
and disappearance of the main grazer Daphnia curvirostris

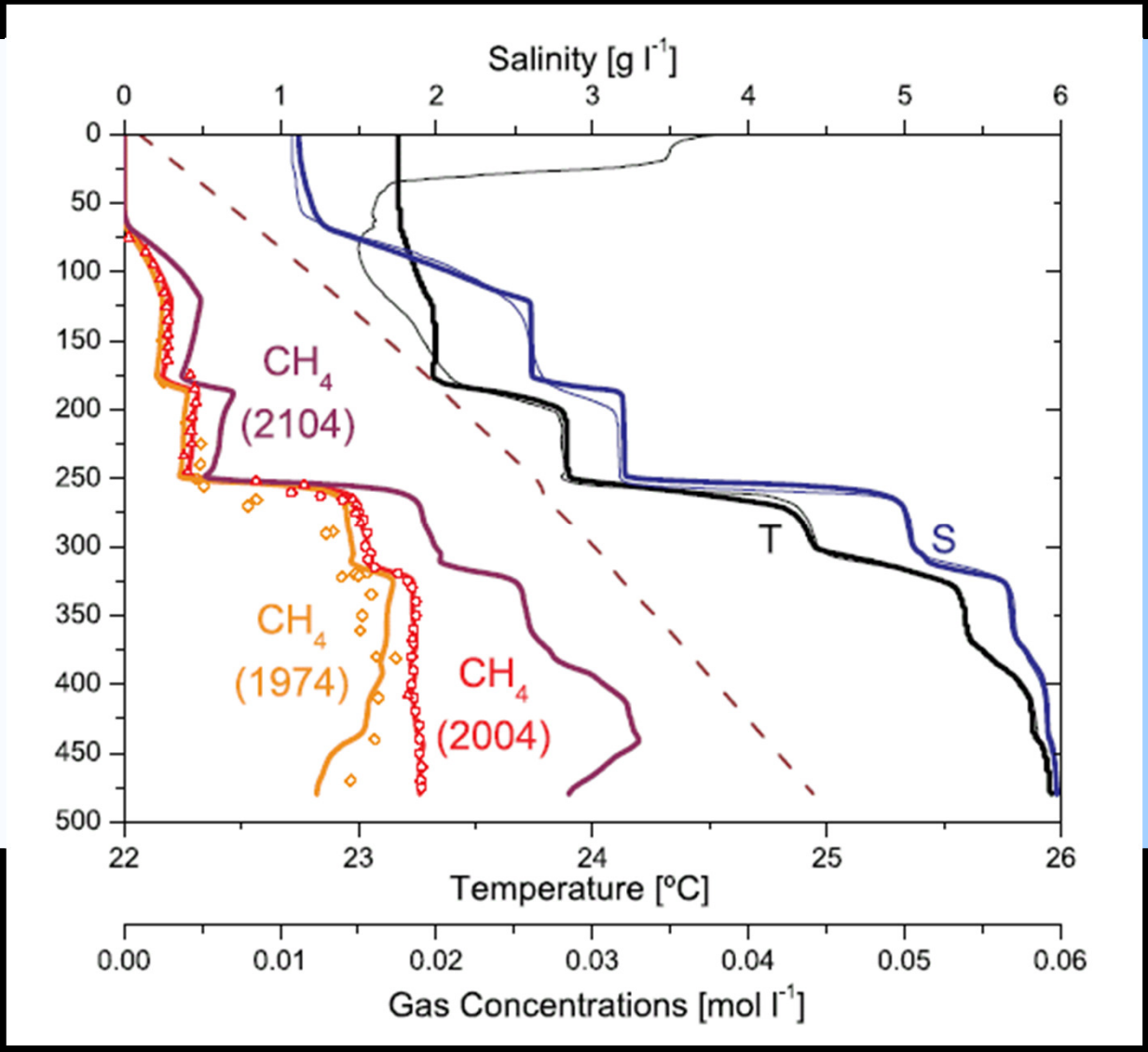
The sardine introduction may have changed the food web and carbon / nutrient cycles in Lake Kivu

No fish predator in Lake Kivu: no predation control of the planktivore

Large predation pressure on zooplankton and disappearance of *Daphnia*

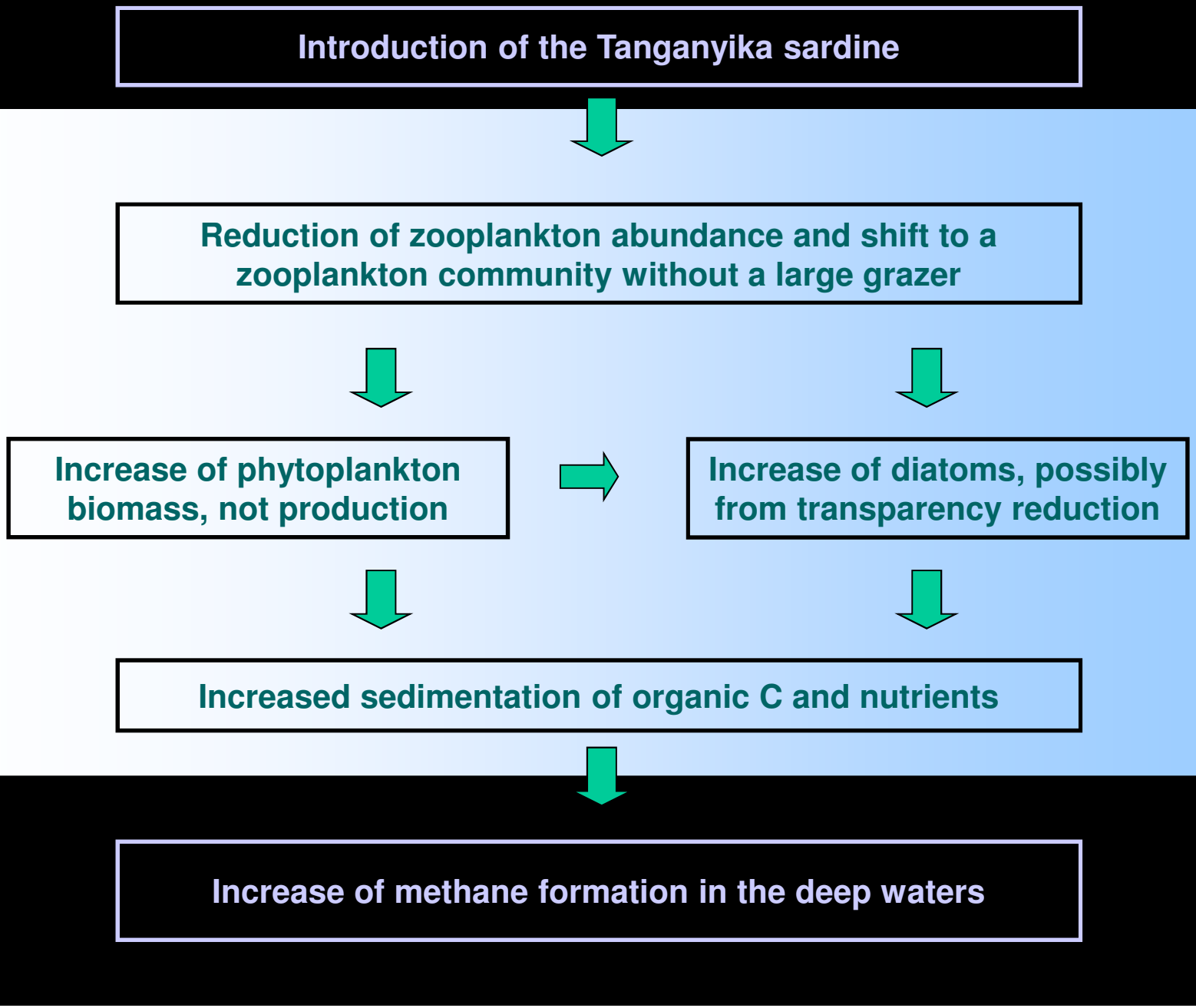
Increased phytoplankton biomass and/or changes in the assemblage

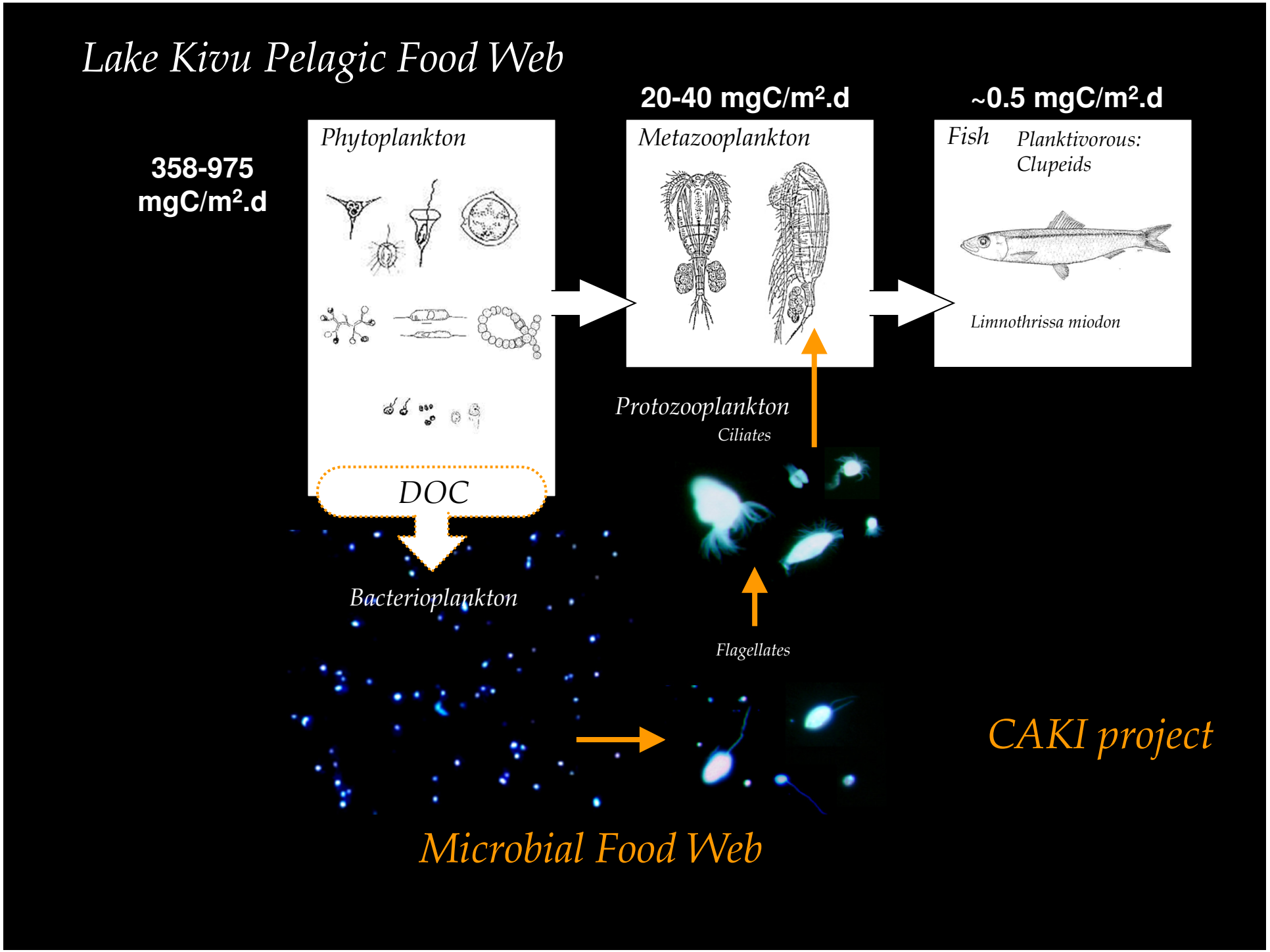
Increasing methane in the deep waters: another, unexpected consequence of the sardine introduction?



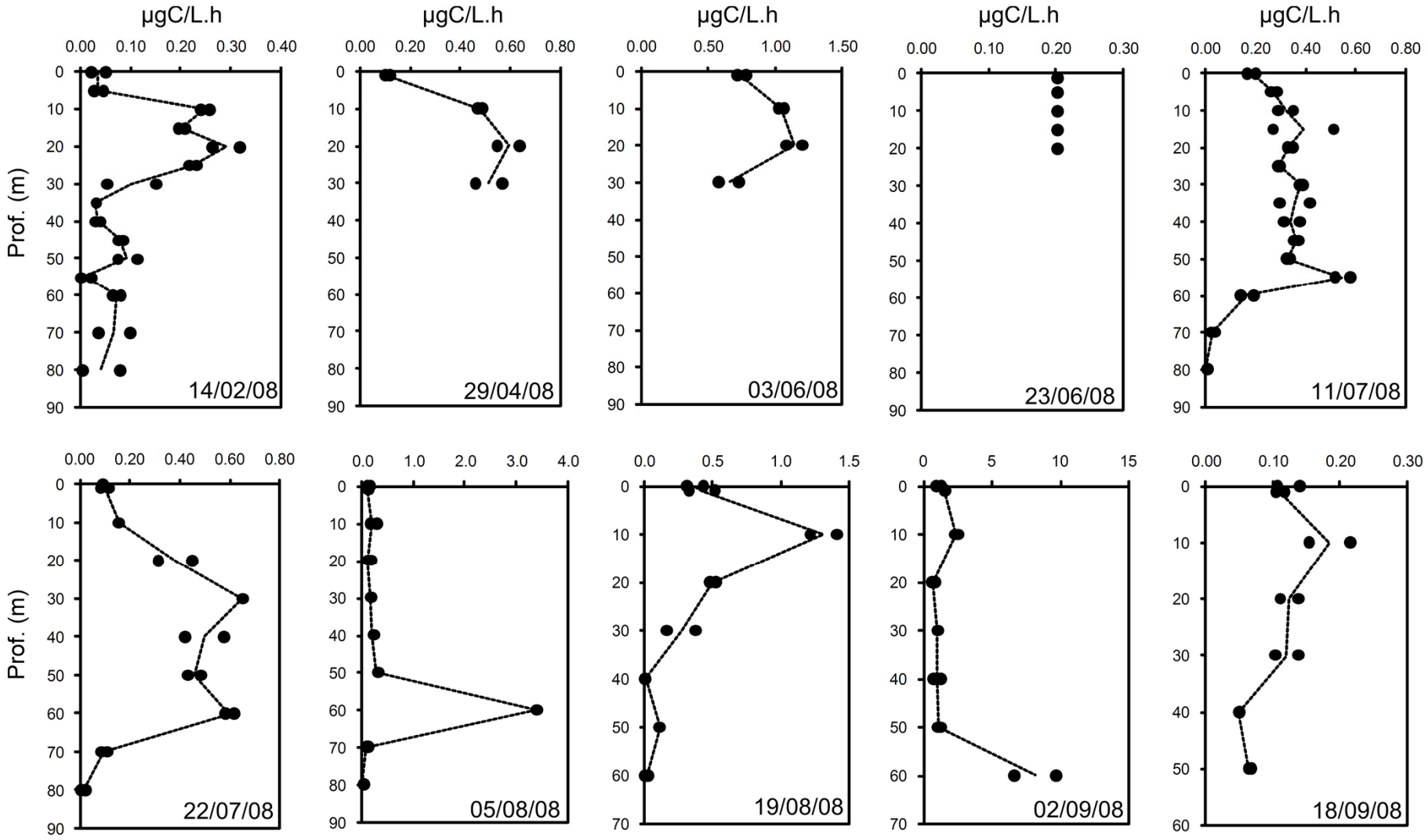
G3 - Geochemistry Geophysics Geosystems, Schmid *et al.*, 2005

Possible causes for methane increase in the deep waters

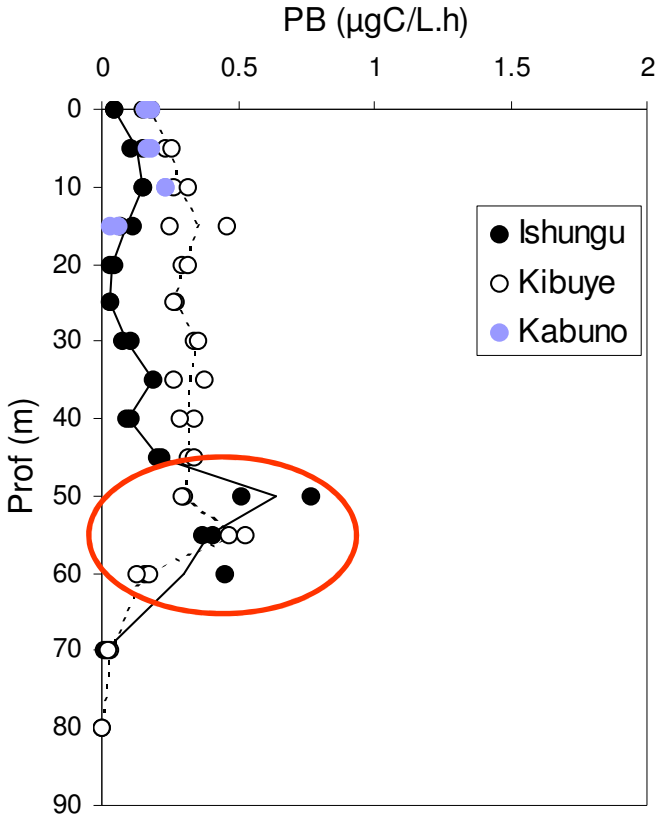


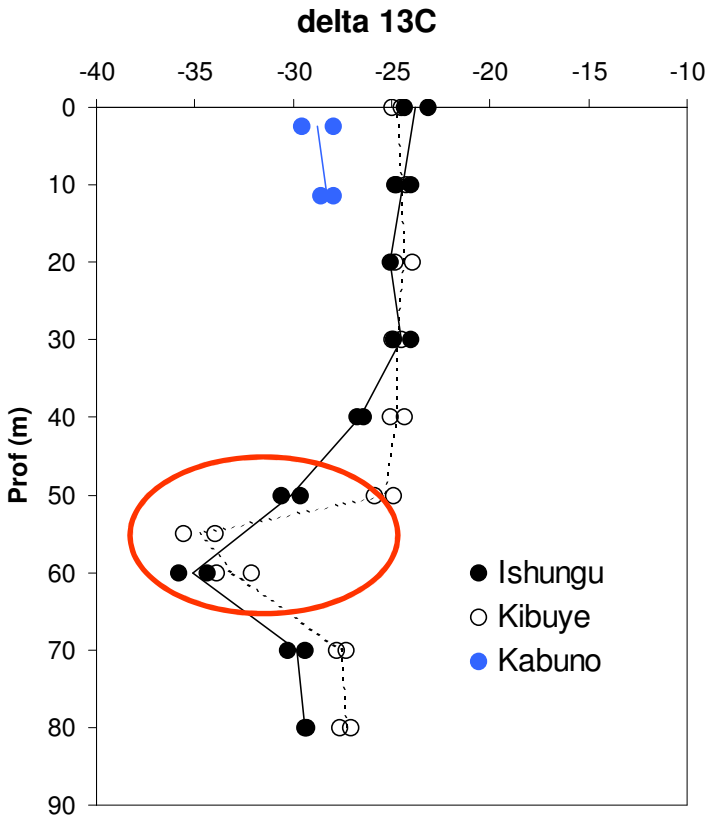

Lake Kivu Pelagic Food Web
358-975 mgC/m².d
Phytoplankton
20-40 mgC/m².d
Metazooplankton
~0.5 mgC/m².d
Fish
Planktivorous: Clupeids
Limnothrissa miodon
Protozooplankton
Ciliates
DOC
Bacterioplankton
Flagellates
CAKI project
Microbial Food Web

Bacterioplankton

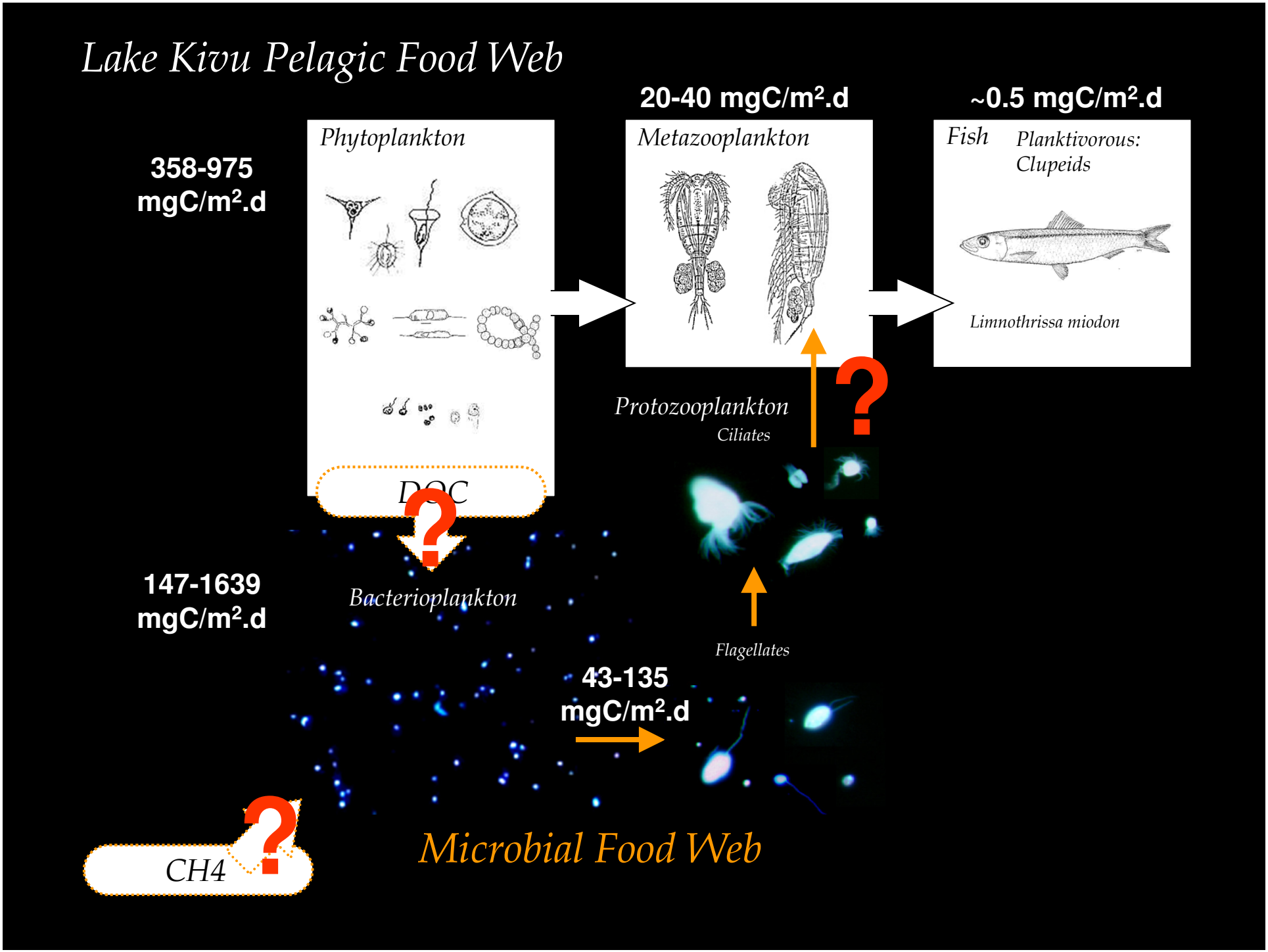


Bacterioplankton





Bacterial plate linked to CH_4 metabolism (C isotope study)
Presence of methanogenic bacteria (specific fatty acids) and methanogenic Euryarchaeota (16S rRNA)


Lake Kivu Pelagic Food Web
20-40 mgC/m².d
~0.5 mgC/m².d
358-975
mgC/m².d
Phytoplankton
Metazooplankton
Fish
Planktivorous:
Clupeids
Limnothrissa miodon
Protozooplankton
Ciliates
?
DOC
?
147-1639
mgC/m².d
Bacterioplankton
Flagellates
43-135
mgC/m².d
CH4
?
Microbial Food Web

Perspectives for 2009

- permanent mooring at Ishungu station with
  - Chla and phycoeryhtrin fluorometers
  - optode (O_2)
  - minilogs (thermometers)
- study of coupling between bacterial and zooplankton production (Nathalie's thesis)
- study of trophic link between metazooplankton and fishes (Pascal's thesis), specially follow-up of a new invader *Lamprichthys tanganycanus*
- modelling of Lake Kivu ecology (Christophe's thesis)
- sediment core analysis (in coll. with E.Verleyen, UGent)

You're welcome !