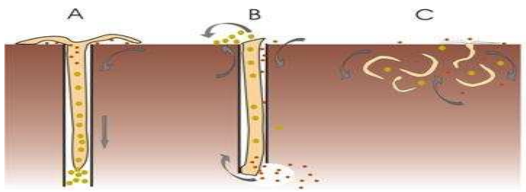
Who's there?


What do they do?
Carrot & radish
THWACK!!
Where's the what's
copyright Fun Phonics Readers www.funphonicsreaders.com

functional diversity in ecological assesment

Tabel 1. Opdeling van het macrobenthos in verschillende functionele groepen.

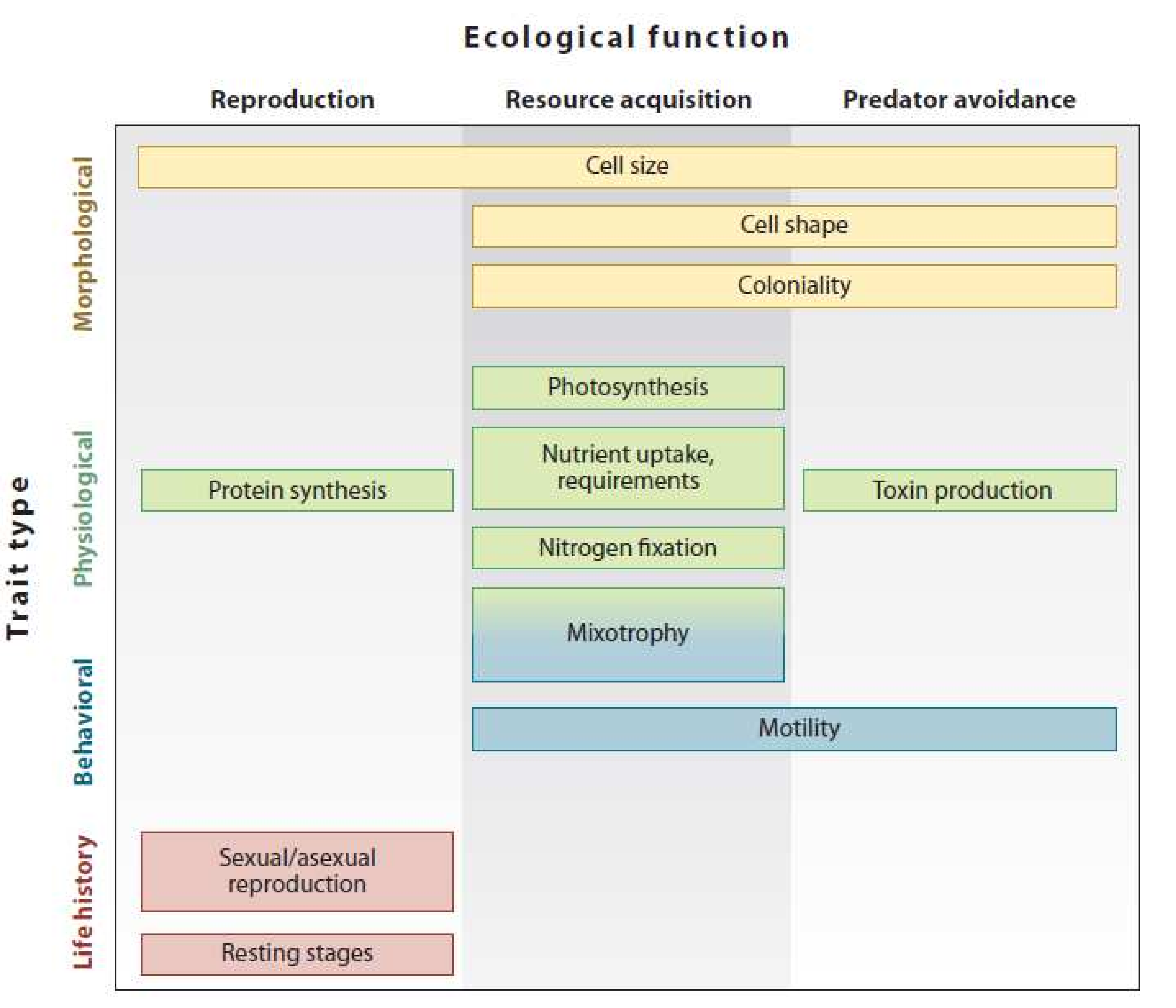
Functie	Activiteit
Mobiliteit	Sedentair of enkel bewegend in een vaste koker
	Gelimiteerde beweging; terugtrekken in het sediment wanneer verstoord
	Vrij bewegend in het sediment zonder permante gangenstelsels. Hiertoe kunnen ook de grazers gerekend worden.
	Vrij bewegend in het sediment in een permanent gangenstelsel
Voeding	Filter feeder of suspension feeder: dieren die zich voeden met gesuspendeerd materiaal, dus in het water zwevend. Dit gebeurt met filtersystemen of met tentakels, waaiers, armen of een slijmnet.
	'Interface' feeder: deze dieren kunnen het voedsel zowel uit het water als van de bodem halen.
	Oppervlakte deposit feeder: soorten die zijn gespecialiseerd in het organisch materiaal (vaak microphytobenthos) dat op de bodem ligt.
	Subsurface deposit feeder: deze dieren leven van organisch materiaal dat in de bodem begraven is. Meestal passeert bij deze dieren een grote hoeveelheid sediment de darm.
	Predatoren: voeden zich in hoofdzaak met andere macrobenthos soorten.
	Omnivoren: vertonen een combinatie van verschillende voedingswijzes.
Bioturbatie	Geen graafactiviteit
	Construction of simple surface hole or pit covering the body in sediment camouflage
	Burrowing by displacement of particles without net particle transport
	Burrowing with selective particle transport
	Burrowing extensively horizontally and/or vertically with particle transport

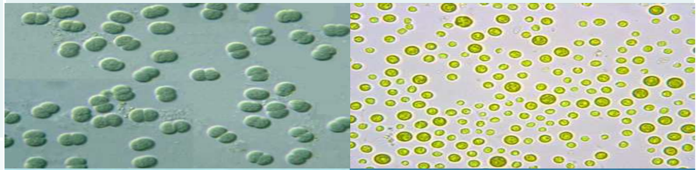
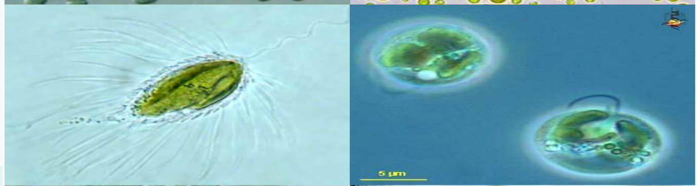
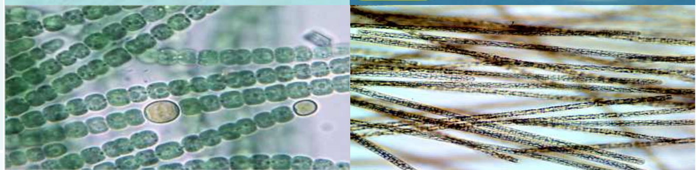
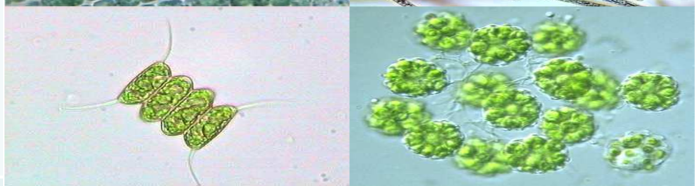
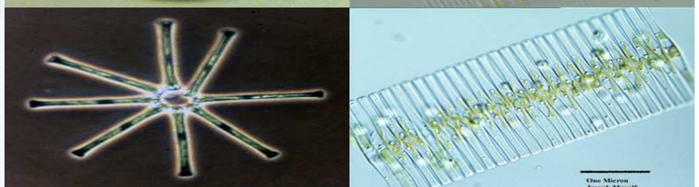
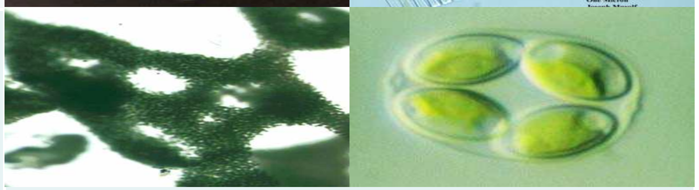
KANAL, PEKING, CHINA...

Vergiftetes Wachstum

Hier ein Papierfetzen, da ein Plastikteil: Der Mann fischt im Auftrag des Staates nach Schmutz in Pekings Gewässern. Die Chinesen merken, dass sie in ihrem Wachstumsehrgeiz die Natur vergewaltigt haben. Das Wasser der sieben grössten Flüsse ist auf einem Viertel ihrer Läufe so vergiftet, dass jeglicher Kontakt für den Menschen schädlich ist. Der Chef der staatlichen Umweltbehörde Chinas kündigte heute an, die Reinigung von Flüssen und Seen zur Top-Priorität zu machen.

key phytoplankton traits



Taxonomic group	Key phenotype	Representative spp
Chlorococcales, Chroococcales Oscillatoriales, Xanthophyceae Ultotrichiales	Small organisms with high SA/V	
Chrysophycea	Small flagellated organisms with siliceous exoskeletal structures	
Nostocales Oscillatoriales	Large filaments with gas-vacuoles	
Chroococcales, Oscillatoriales Xanthophyceae, Zygnematophyceae	Organisms of medium size lacking specialized features	
Cryptophyceae, Dinophyceae Euglenophyceae, Volvocales Chlorococcales	Unicellular flagellates of medium to large size	
Bacillariophyceae	Non-flaggelated organisms with siliceous skeletons	
Chlorococcales Chroococcales Oscillatoriales	Large mucilaginous colony forming organisms	

Kruk et al, Freshw. Biol. 2009

ECOLOGY LETTERS

Ecology Letters, (2009) **12**: 1405–1419 doi: 10.1111/j.1461-0248.2009.01388.x

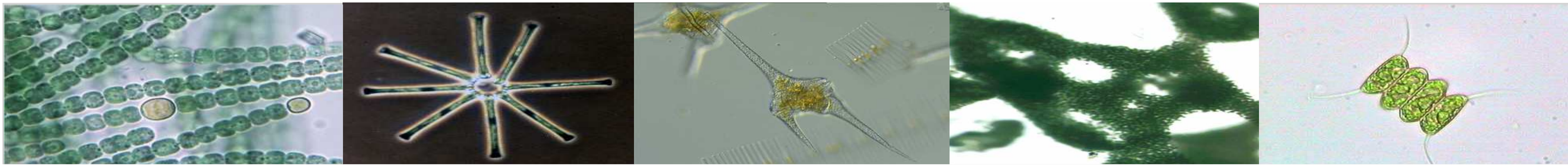
REVIEW AND SYNTHESIS

Biodiversity in a complex world: consolidation and progress in functional biodiversity research

Trait-Based Community Ecology of Phytoplankton

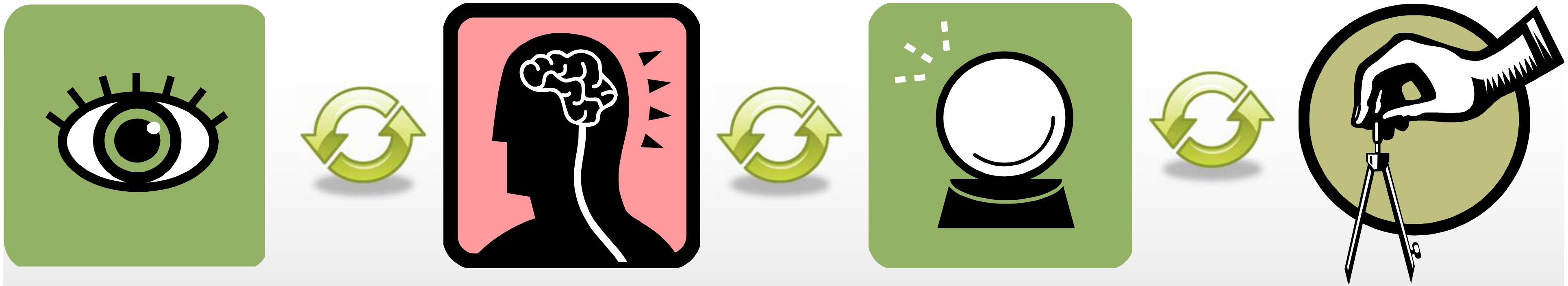
Elena Litchman[1] and Christopher A. Klausmeier[2]

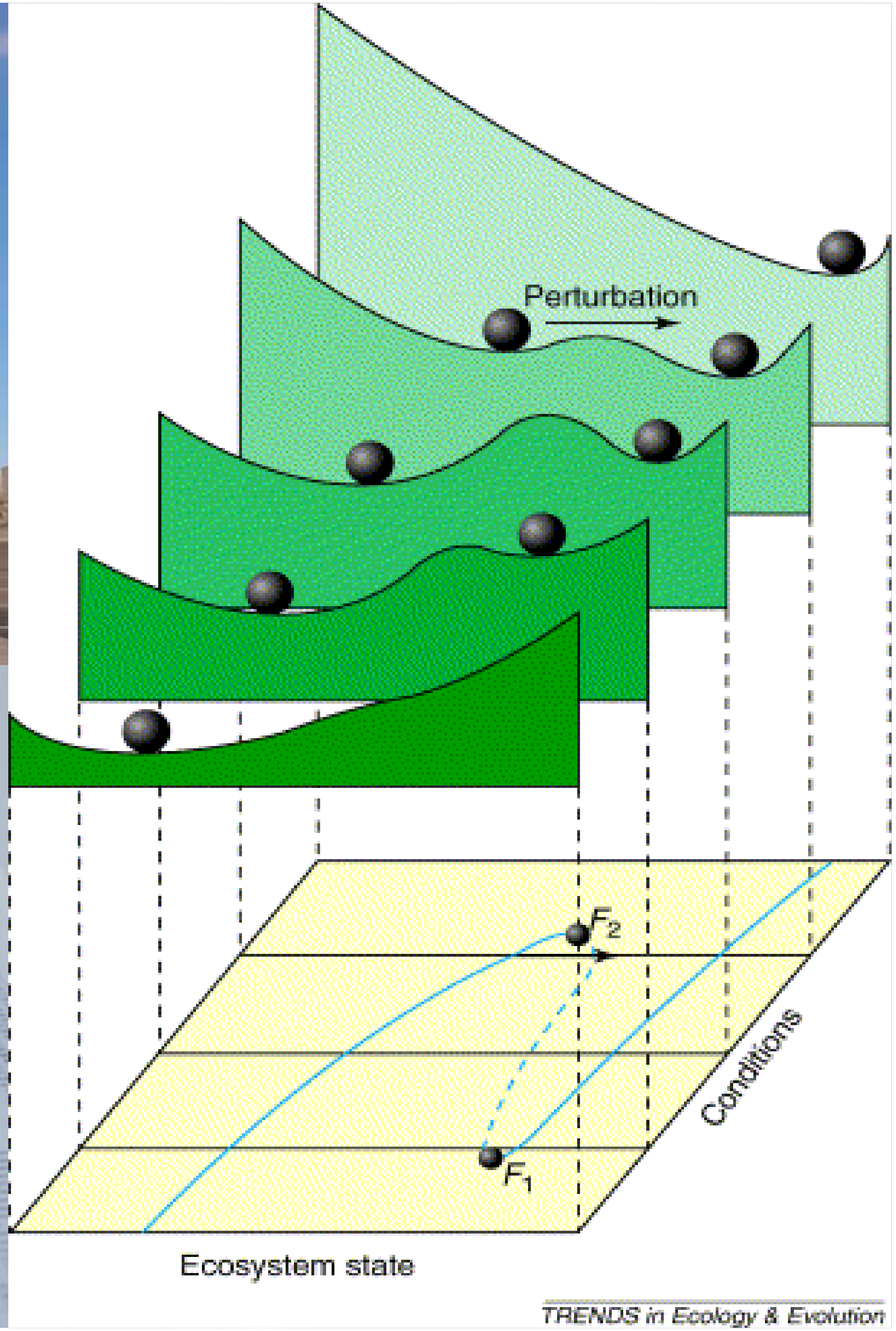
Kellogg Biological Station, [1]Department of Zoology, and [2]Department of Plant Biology, Michigan State University, Hickory Corners, Michigan 49060; email: litchman@msu.edu, klausme1@msu.edu

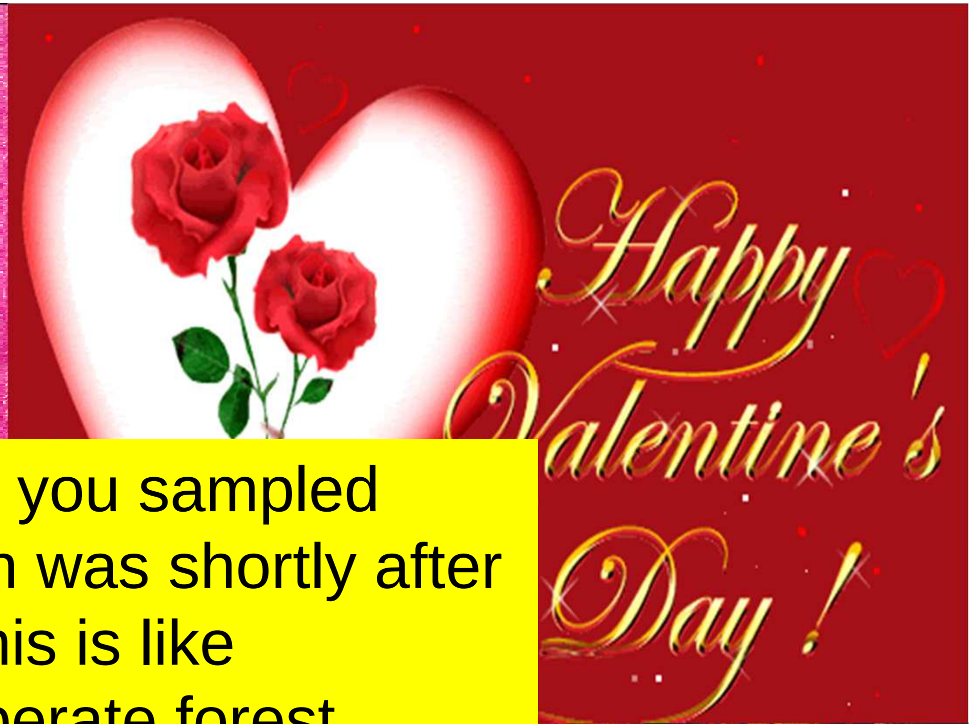


From **Monitoring** towards **Understanding**, **Predicting** and **Managing** Plankton in Changing Aquatic Ecosystems

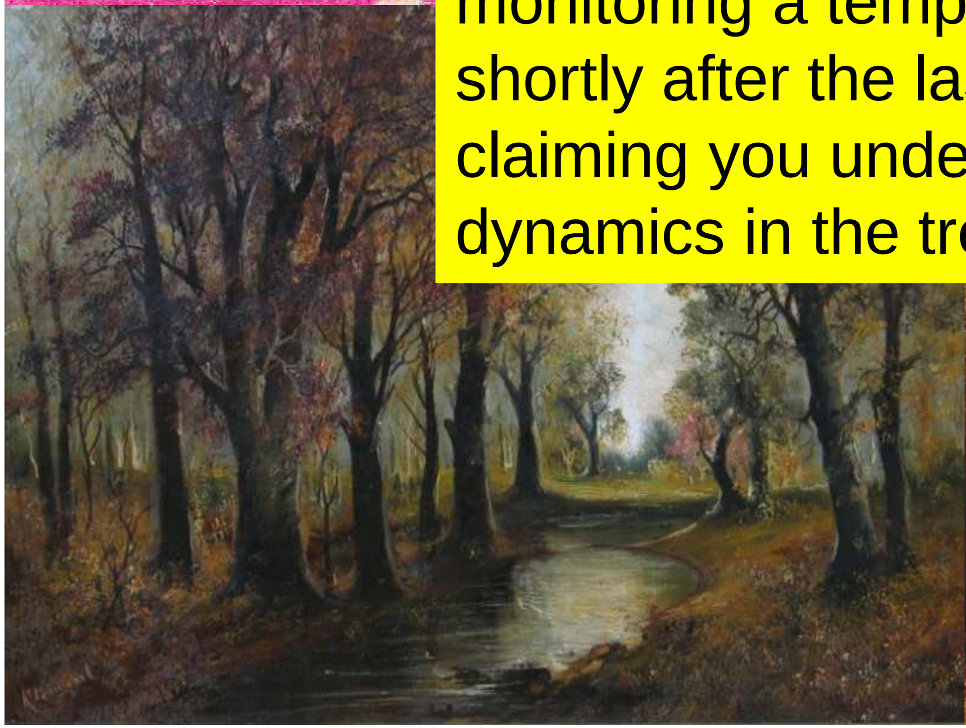
AquaProbe

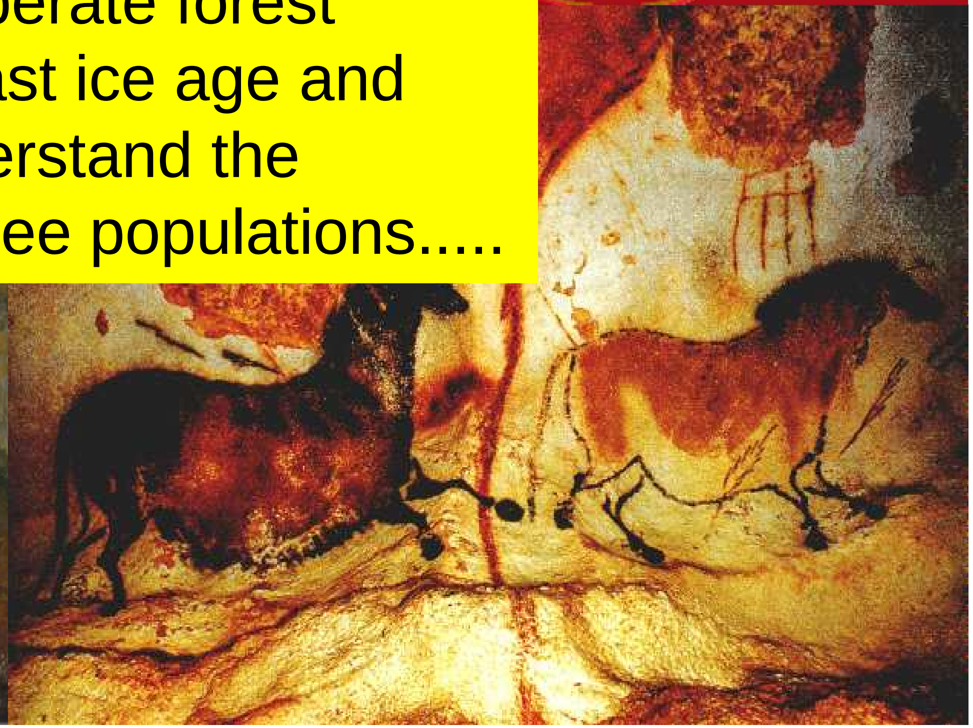



Perturbation
F_2
F_1
Conditions
Ecosystem state
TRENDS in Ecology & Evolution



......if the last time you sampled your lake plankton was shortly after Valentine's day, this is like monitoring a temperate forest shortly after the last ice age and claiming you understand the dynamics in the tree populations.....





requirements lake ecology monitoring platform

- automated high-frequency measurements phytoplankton abundance and diversity
- good resolution over depth (i.e. time and space)
- coupling high frequency plankton measurements to drivers in (physical) environment
- providing remote access for data-download and monitoring-settings upload
- independent energy supply and limited maintenance

ECOLOGY LETTERS

Ecology Letters, (2009) **12**: 1405–1419 doi: 10.1111/j.1461-0248.2009.01388.x

REVIEW AND SYNTHESIS

Biodiversity in a complex world: consolidation and progress in functional biodiversity research

Trait-Based Community Ecology of Phytoplankton

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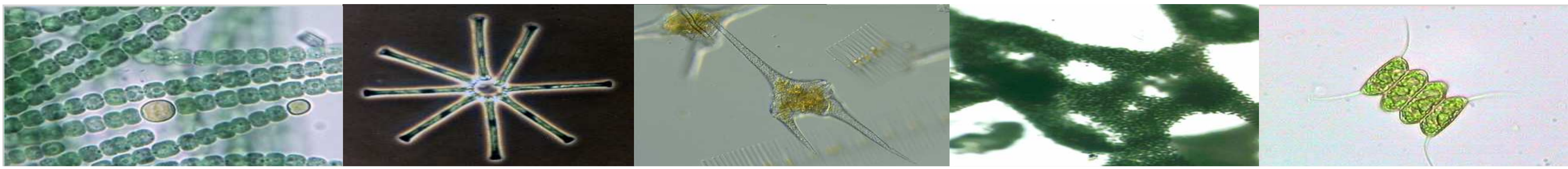
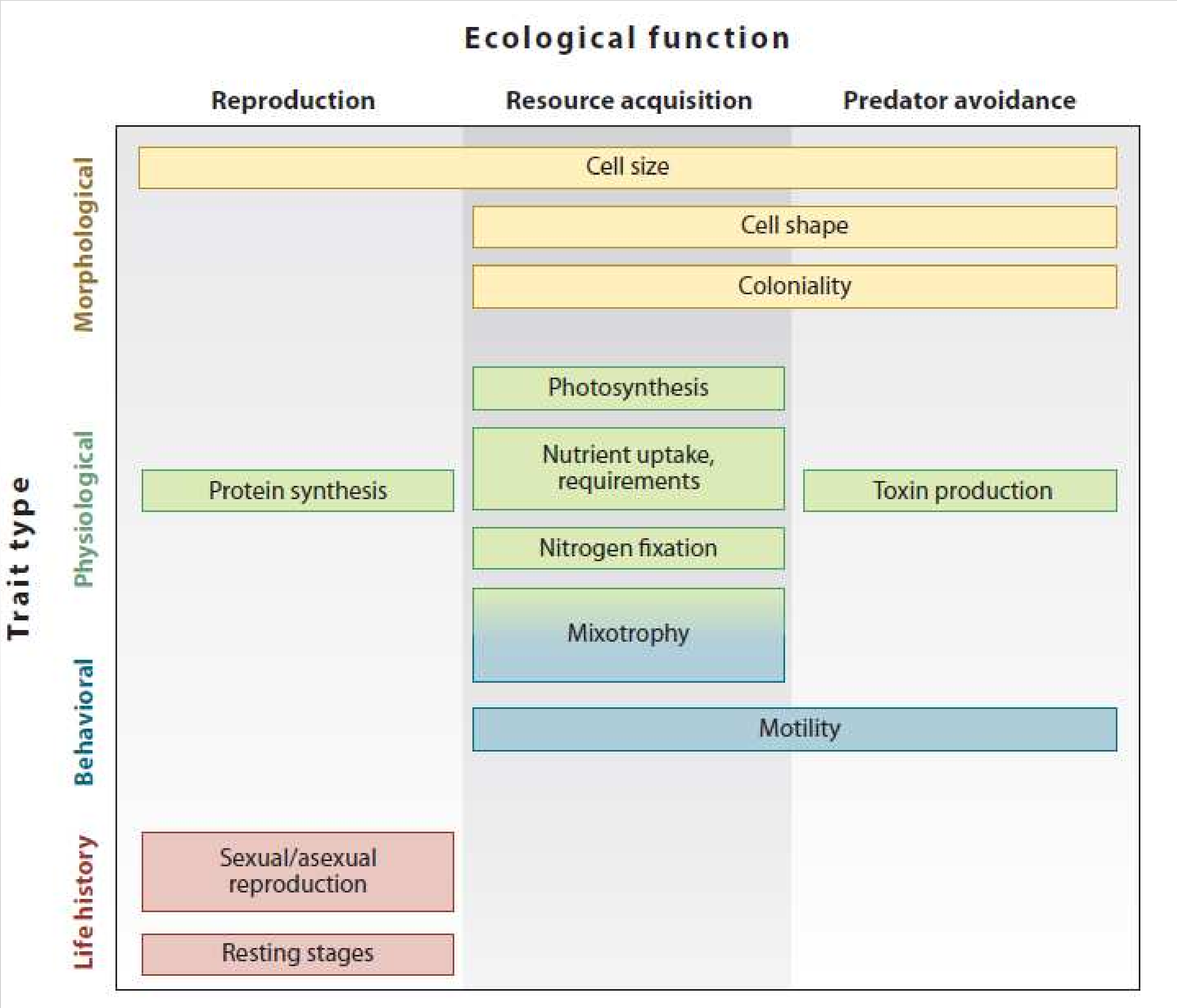


key phytoplankton traits




eawag
aquatic research

Environmental Science & Technology

Article

An Automated Platform for Phytoplankton Ecology and Aquatic Ecosystem Monitoring

Francesco Pomati, Jukka Jokela, Marco Simona, Mauro Veronesi, and B. W. Ibelings

Environ. Sci. Technol., **Just Accepted Manuscript** • DOI: 10.1021/es201934n • Publication Date (Web): 07 Oct 2011

Just Accepted

monitoring the environment

multiparameter probe

Sensors:

- Pressure
- Temperature
- Conductivity
- Oxygen
- pH
- NO_3
- Chl-a
- Phycocyanin
- Phycoerithrin
- PAR

Surface data logger:

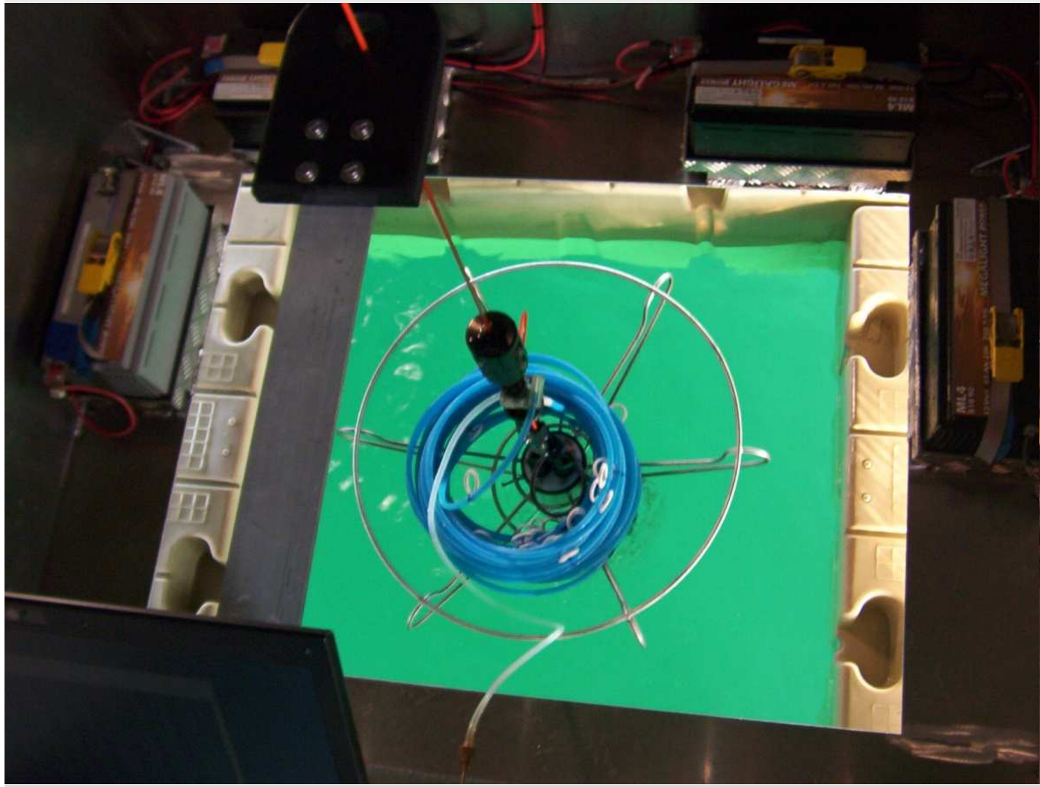
- PAR
- UV

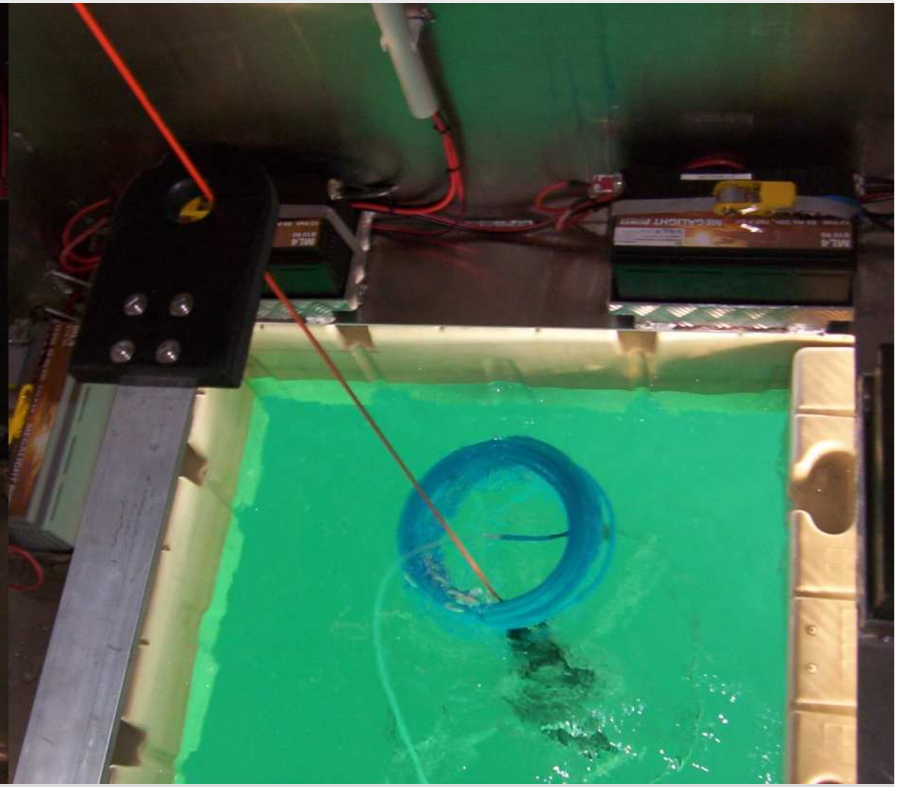
Meteo station

WISP

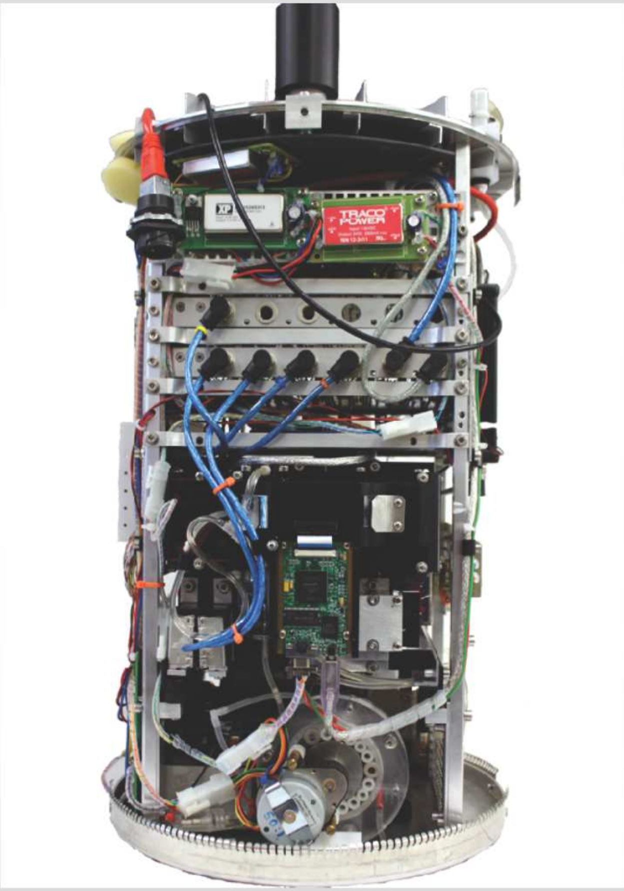
IDRONAUT OCEAN SEVEN 316Plus CTD PROBE
20Hz SAMPLING RATE - REAL-TIME AND SELF-RECORDING CAPABILITY

automated vertical profiling in operation

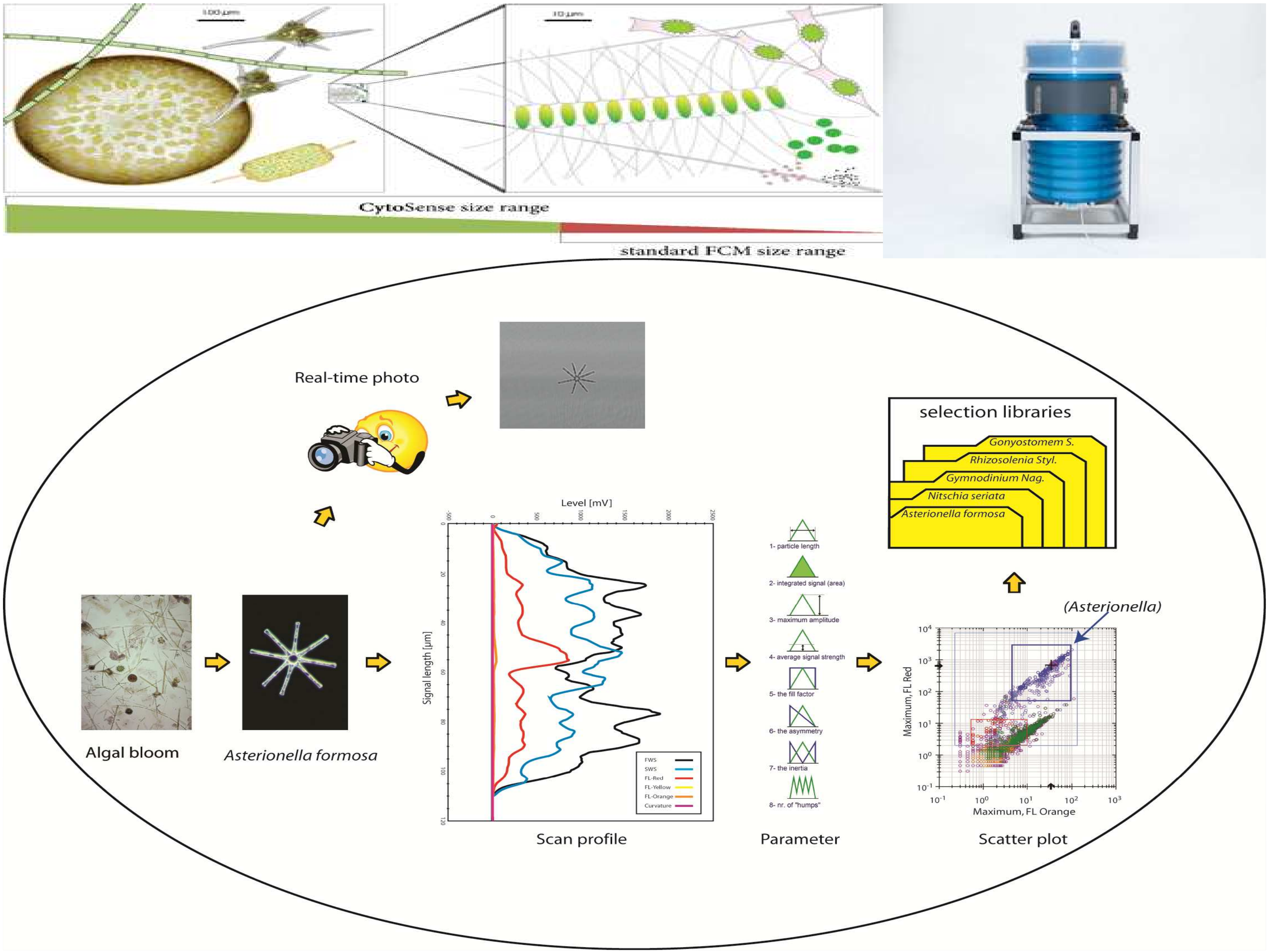




flowcytometry to quantify phytoplankton

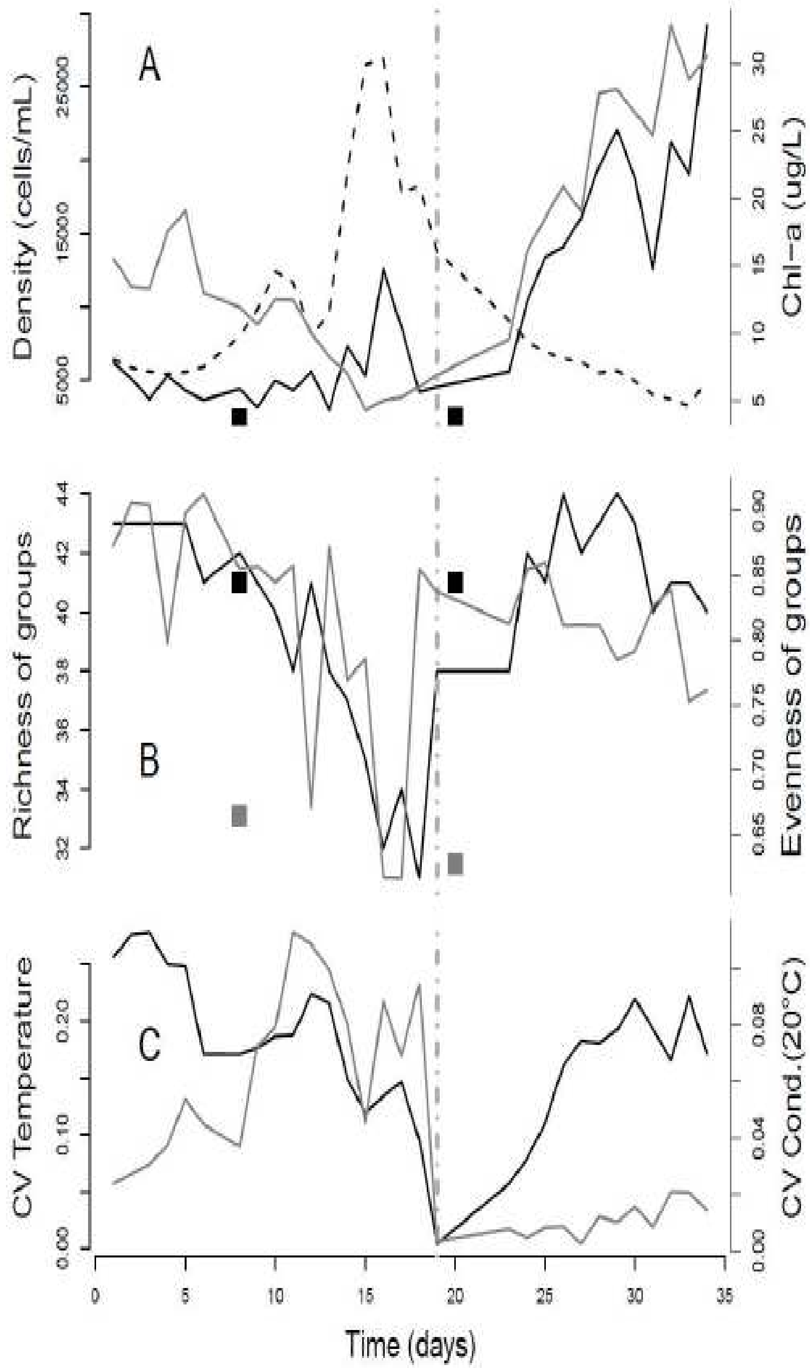


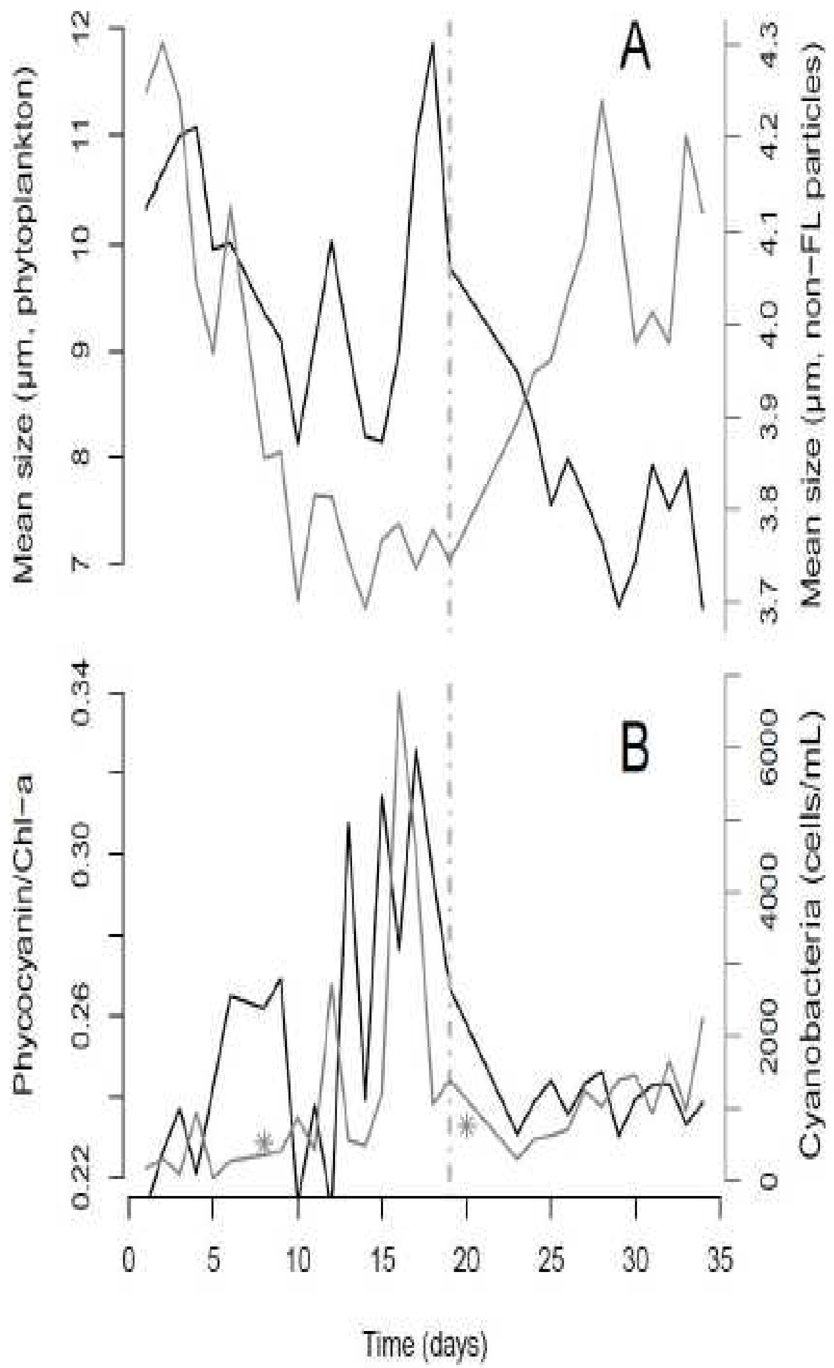
CytoBuoy



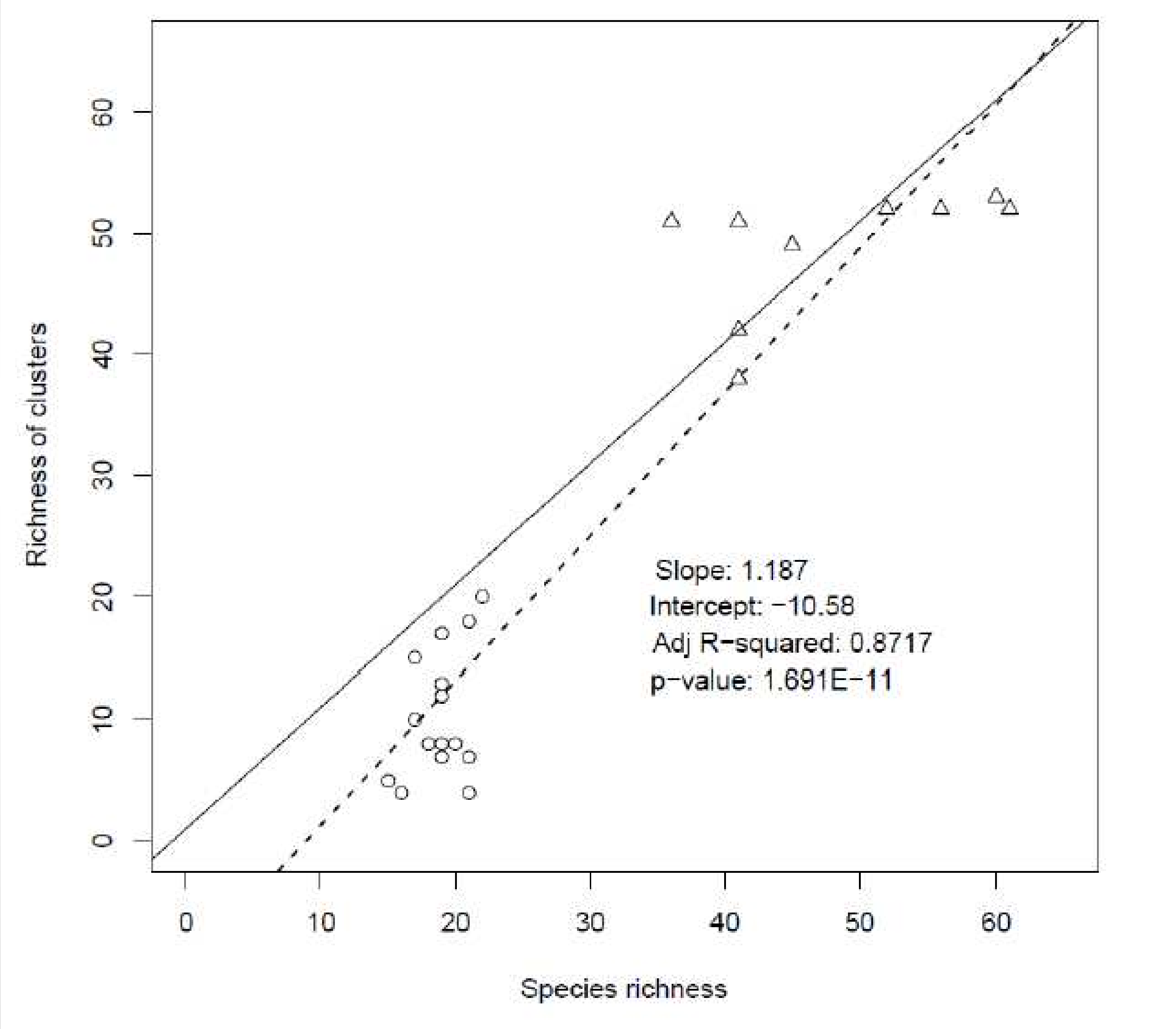
CytoSense size range
standard FCM size range
Real-time photo
selection libraries
Gonyostomem S.
Rhizosolenia Styl.
Gymnodinium Nag.
Nitschia seriata
Asterionella formosa
(Asterionella)
Level [mV]
Signal length [µm]
FWS
SWS
FL-Red
FL-Yellow
FL-Orange
Curvature
1- particle length
2- integrated signal (area)
3- maximum amplitude
4- average signal strength
5- the fill factor
6- the asymmetry
7- the inertia
8- nr. of "humps"
Maximum, FL Red
Maximum, FL Orange
Algal bloom
Asterionella formosa
Scan profile
Parameter
Scatter plot

Feature*	Classical Limnology	Automated platform
Number of samples year^{-1} (n)	12-18[a]	> 700[b]
Lag (Δ)	2 weeks – 1 month	12 h
Fundamental Period ($T_0 = \Delta n$)	12	> 700
Frequency ($1/T_0$)	0.083	0.0014
Nyquist frequency ($1/2\Delta$), highest possible frequency	1-2 months (6-12 cycles year^{-1})	24 h (365 cycles year^{-1})
Resolution of depth gradient	from 1 integrated to 10 samples over photic zone	from 6 to 12 samples over photic zone
Phytoplankton density and physio-morphological traits	estimated from circa 200-500 counts / in 100-200 mL	from circa 30,000 counts / in 100-400 µL volume
Number of descriptors measured per individual	2 (size, volume)	54 (3D descriptors, pigment type, concentration etc.)
Estimation of diversity	taxonomic, functional	Functional
Number of taxa groups	14 to 61 per sample[c]	NA
Number of functional groups	5 to 20 per sample[c]	4 to 53 per sample[c]
Reproducibility / repeatability of data	low[d]	high [27][e]


A
Density (cells/mL)
Chl-a (ug/L)
B
Richness of groups
Evenness of groups
C
CV Temperature
CV Cond.(20°C)
Time (days)


A
Mean size (µm, phytoplankton)
Mean size (µm, non-FL particles)
B
Phycocyanin/Chl-a
Cyanobacteria (cells/mL)
Time (days)

functional vs. species richness



take home

Our automated platform provided high frequency data on phytoplankton abundance and functional diversity at different lake depths. It detected dynamics in the community that were completely missed by traditional limnological techniques.

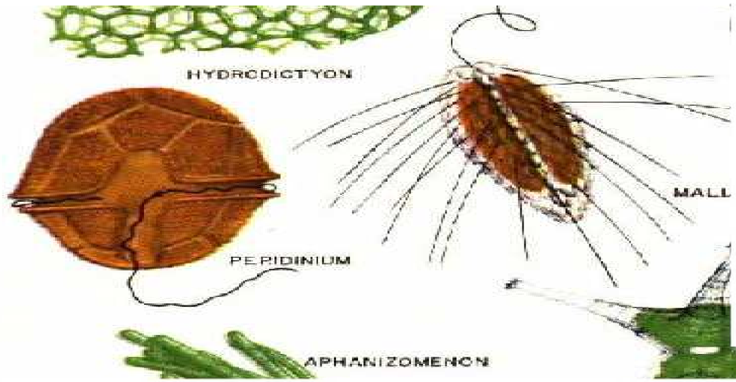

3
ASSEMBLY of
LAKE
PHYTOPLANKTON
COMMUNITIES

Vol. XCV, No. 882 The American Naturalist May–June, 1961

THE PARADOX OF THE PLANKTON*

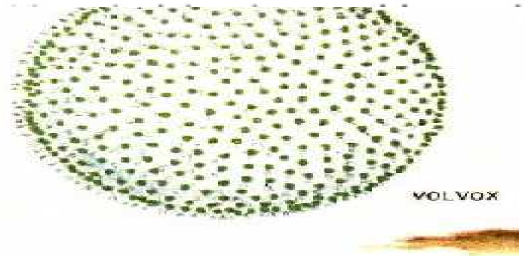
G. E. HUTCHINSON

Osborn Zoological Laboratory, New Haven, Connecticut



The problem that is presented by the phytoplankton is essentially how it is possible for a number of species to coexist in a relatively isotropic or unstructured environment all competing for the same sorts of materials. The problem is particularly acute because there is adequate evidence from enrichment experiments that natural waters, at least in the summer, present an environment of striking nutrient deficiency, so that competition is likely to be extremely severe.

According to the principle of *competitive exclusion* (Hardin, 1960) known by many names and developed over a long period of time by many investigators (see Rand, 1952; Udvardy, 1959; and Hardin, 1960, for historic reviews), we should expect that one species alone would outcompete all the others so that in a final equilibrium situation the assemblage would reduce to a population of a single species.



Twenty years ago in a Naturalists' Symposium, I put (Hutchinson, 1941) forward the idea that the diversity of the phytoplankton was explicable primarily by a permanent failure to achieve equilibrium as the relevant external factors changed. I later pointed out that equilibrium would never be exnews feature

Neutrality versus the niche

ECOLOGY

Return of the niche

Niche:

- species are different
- large fitness differences
- niches act as stabilising factors, allowing co-existence
- community assembly
  - species interactions
  - environmental filtering

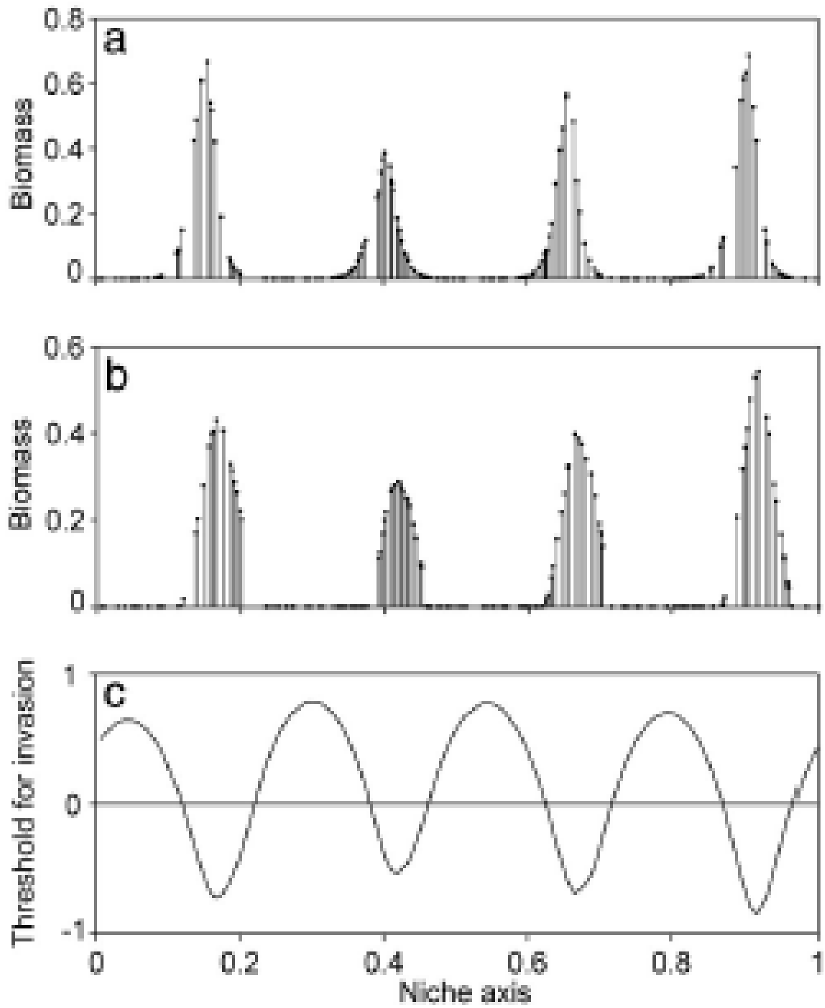
Neutral:

- species interchangeable
- small fitness differences
- co-existence patterns random
- community assembly
  - dispersal
  - stochasticity demography

Self-organized similarity, the evolutionary emergence of groups of similar species

Marten Scheffer* and Egbert H. van Nes

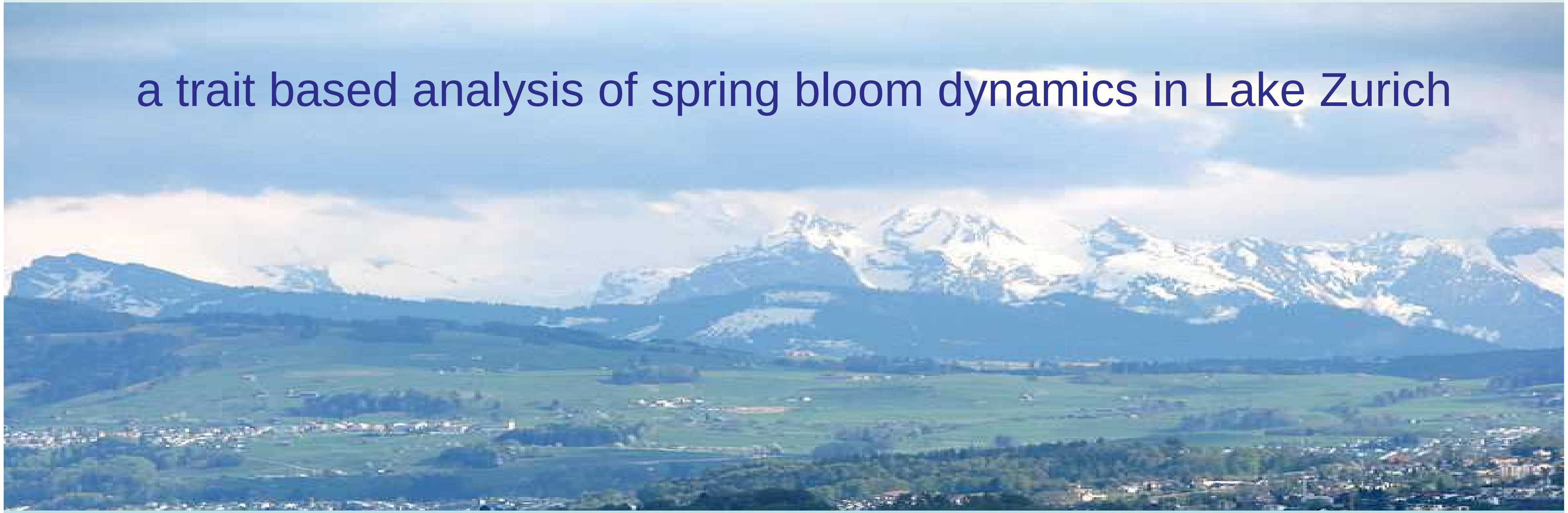
Aquatic Ecology and Water Quality Management Group, Department of Environmental Sciences, Wageningen University, P.O. Box 8080, 6700 DD, Wageningen, The Netherlands



Aims:

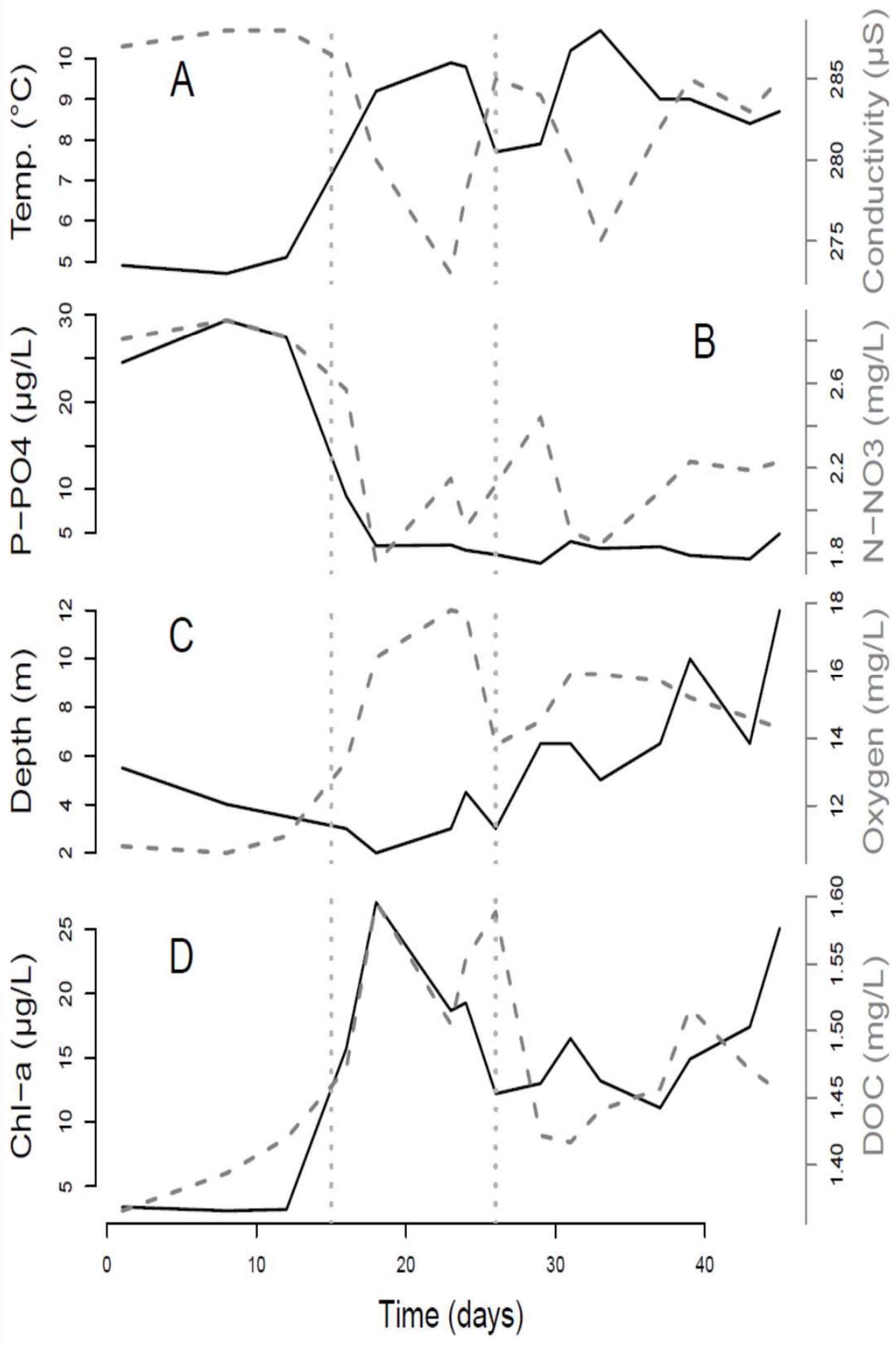
- to study how functional groups and their expressed trait values respond to environmental conditions during a period of rapid change (spring)
- to understand how community wide distributions of response traits change during the process of community assembly steering succession in phytoplankton spring bloom
- to compare the outcome of community assembly to theoretical predictions

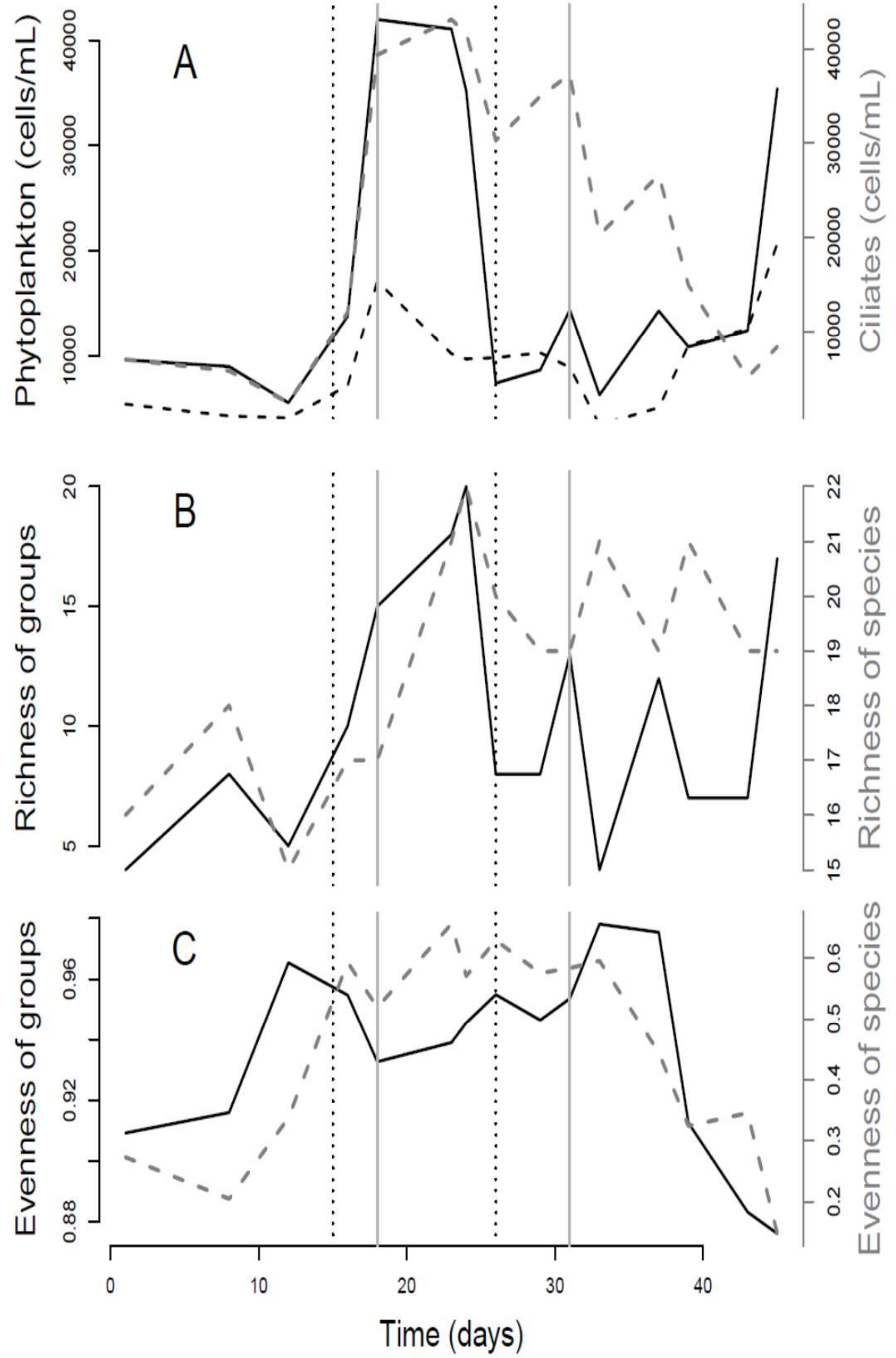
a trait based analysis of spring bloom dynamics in Lake Zurich



- environmental filtering should limit the range of strategies found in a community
  - ➢ shifts in mean of traits, reduced range or variance
- niche differentiation should spread individuals evenly along trait axes
- relevant metrics weighed against null expectation of random assembly

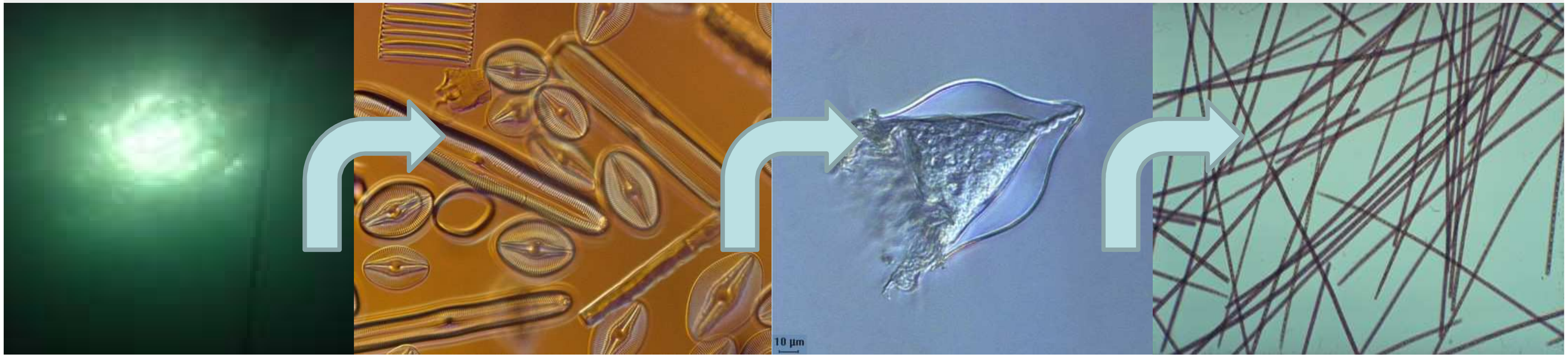
Pomati, Ibelings et al. ISME-J, *submitted*


A
B
C
D
Temp. (°C)
Conductivity (µS)
P−PO4 (µg/L)
N−NO3 (mg/L)
Depth (m)
Oxygen (mg/L)
Chl−a (µg/L)
DOC (mg/L)
Time (days)


A
B
C
Phytoplankton (cells/mL)
Ciliates (cells/mL)
Richness of groups
Richness of species
Evenness of groups
Evenness of species
Time (days)

trait based analysis of dominant community processes during phytoplankton spring bloom

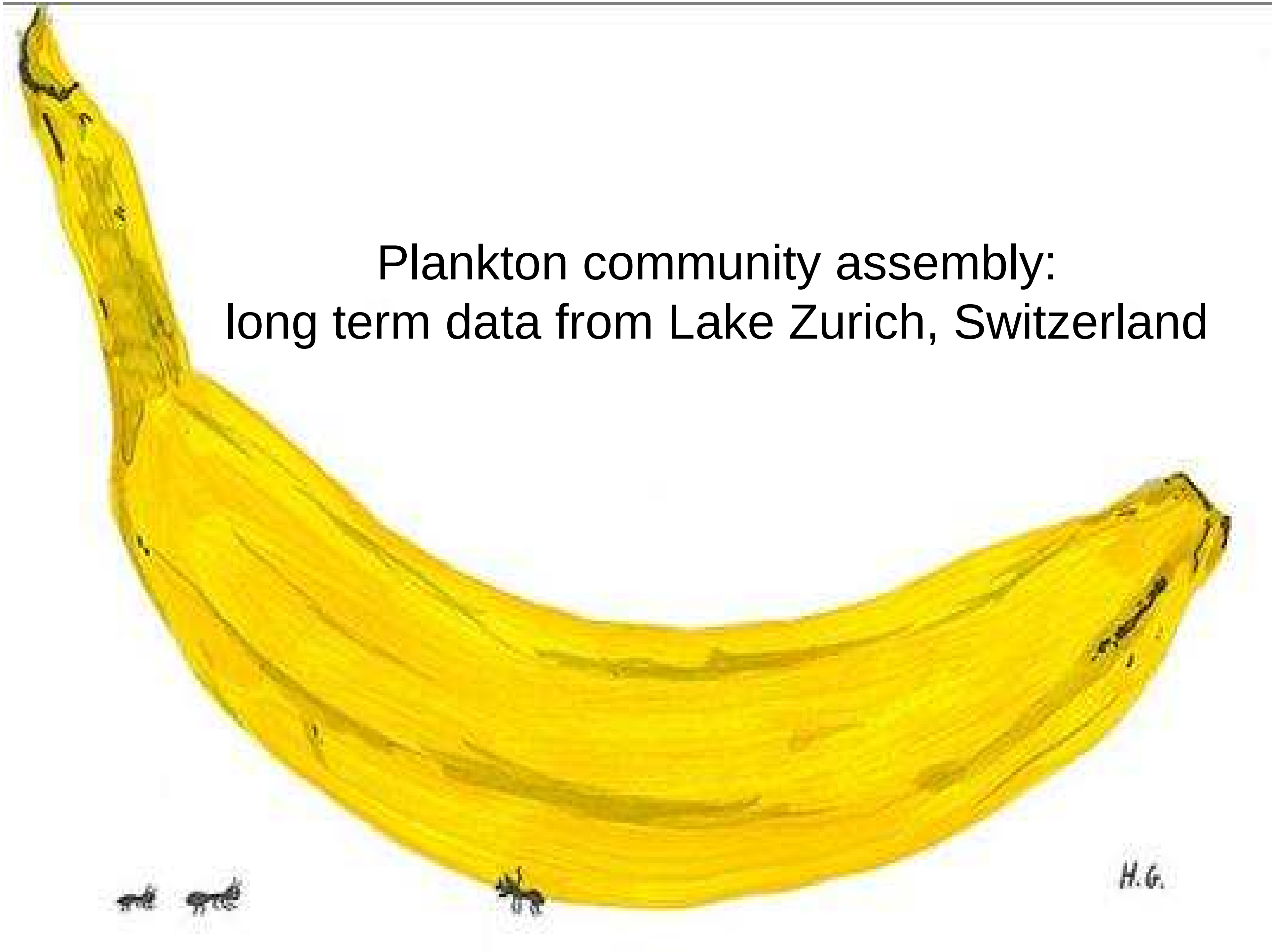
	Trait patterns	
Process	Habitat-occupancy traits	Species-interaction traits
Environmental filtering	clustering (converging on similar traits)	random
Competition	random or clustered	evenly dispersed trait axes
Predation / grazing	random or clustered	evenly dispersed trait axes



take home

Our flowcytometry based analysis of patterns in functional phytoplankton traits gave clear evidence of non-random niche effects - mainly strong species interactions against a background of environmental filtering - in steering the spring bloom succession. Pivotal roles for cell size and pigmentation in shaping phytoplankton communities under pressure from competition and predation.

Plankton community assembly:
long term data from Lake Zurich, Switzerland



Dr Zürisee het d'Form vonerä Bananä

Aims:

- to investigate the relationship between changes in environment and plankton community structure over a long term period
- to look at the relative roles of niche based and neutral mechanisms in co-existence of Lake Zurich phytoplankton

➢Wasserversorgung Zürich time-series (deepest point in Thalwil)

- Monthly sampling
- 14 depths
- 1976-2008

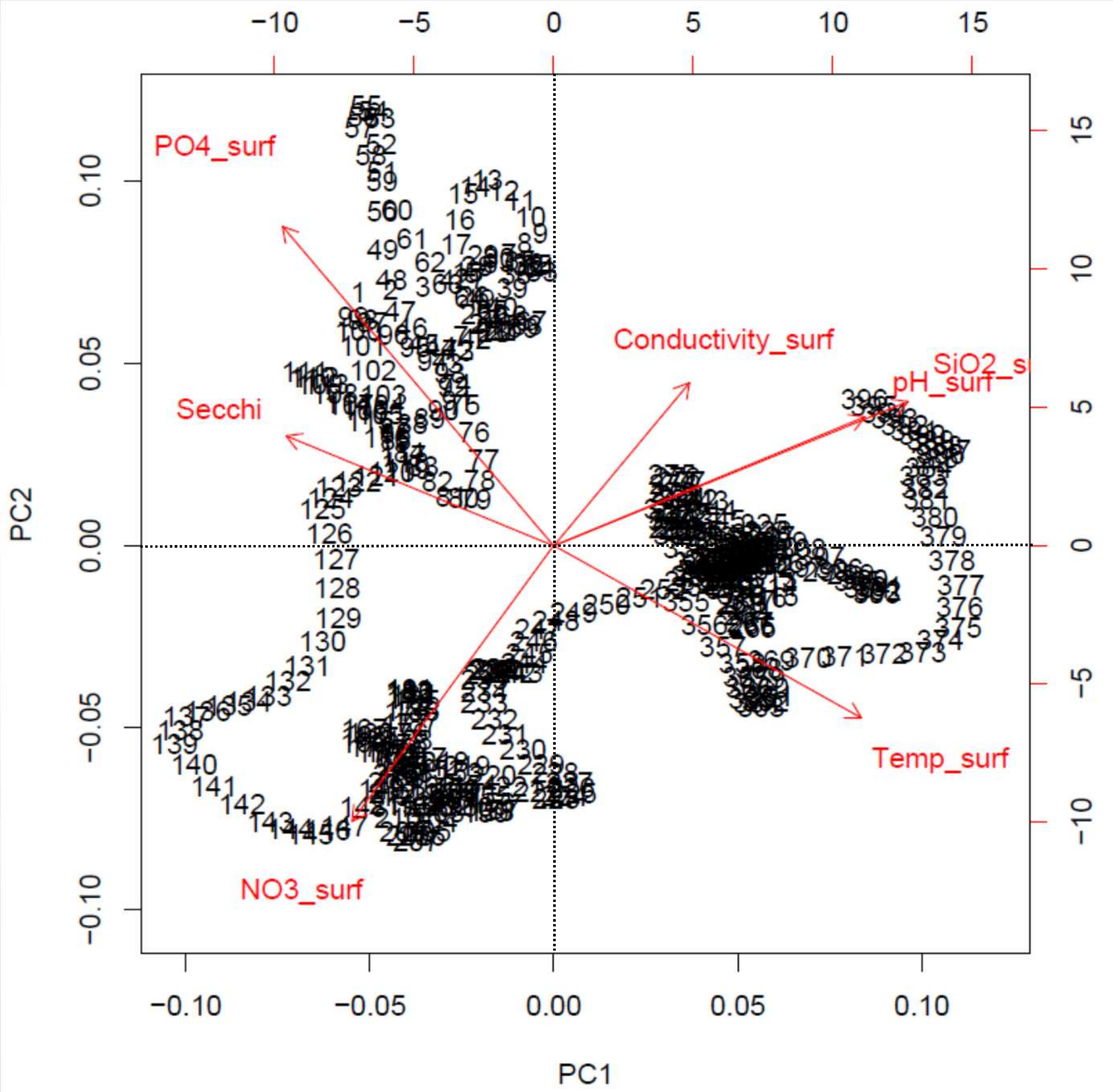
Oikos 000: 001–011, 2011
doi: 10.1111/j.1600-0706.2011.20055.x

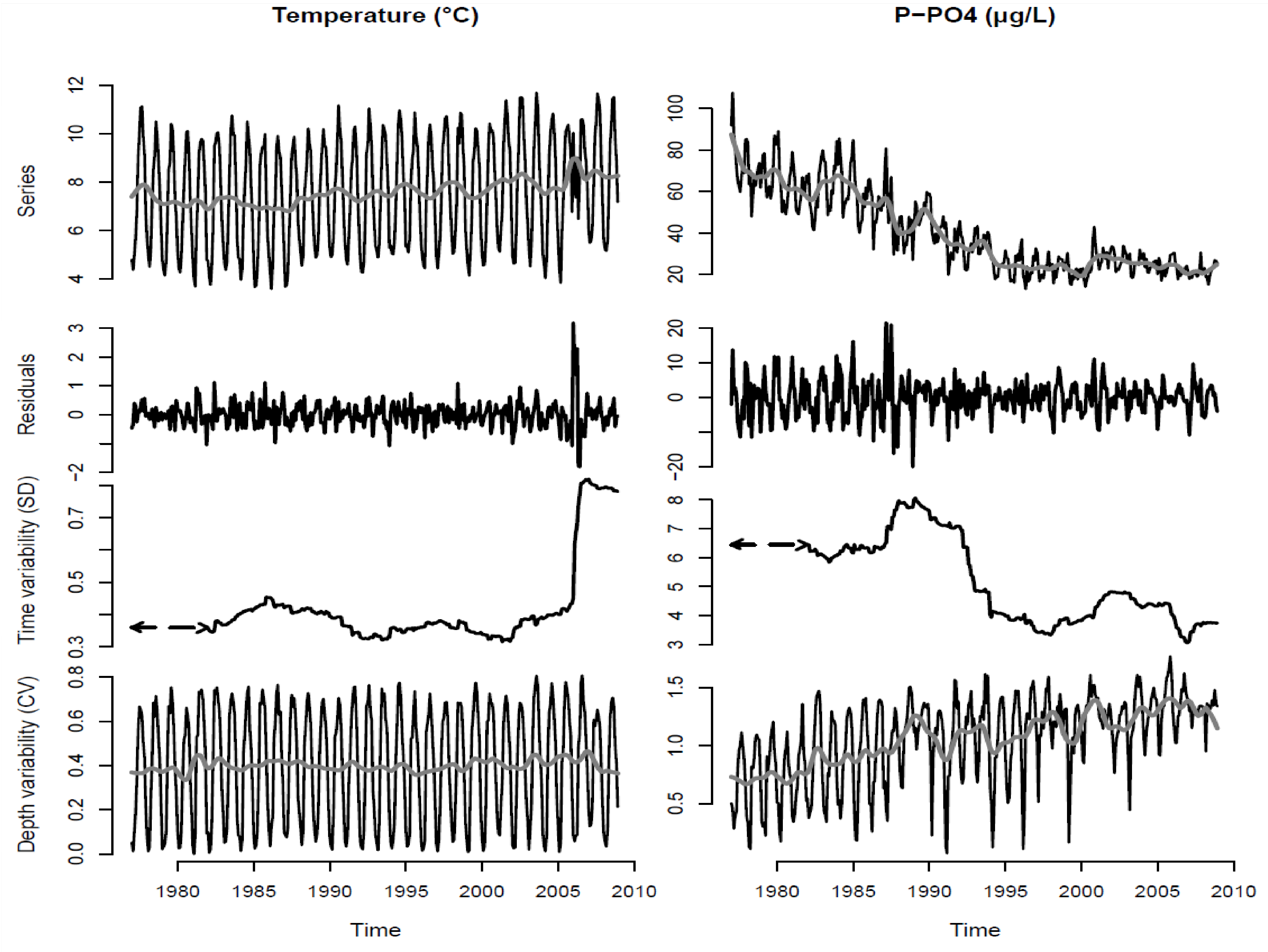
Subject Editor: Lars-Anders Hansson. Accepted 13 September 2011

Effects of re-oligotrophication and climate warming on plankton richness and community stability in a deep mesotrophic lake

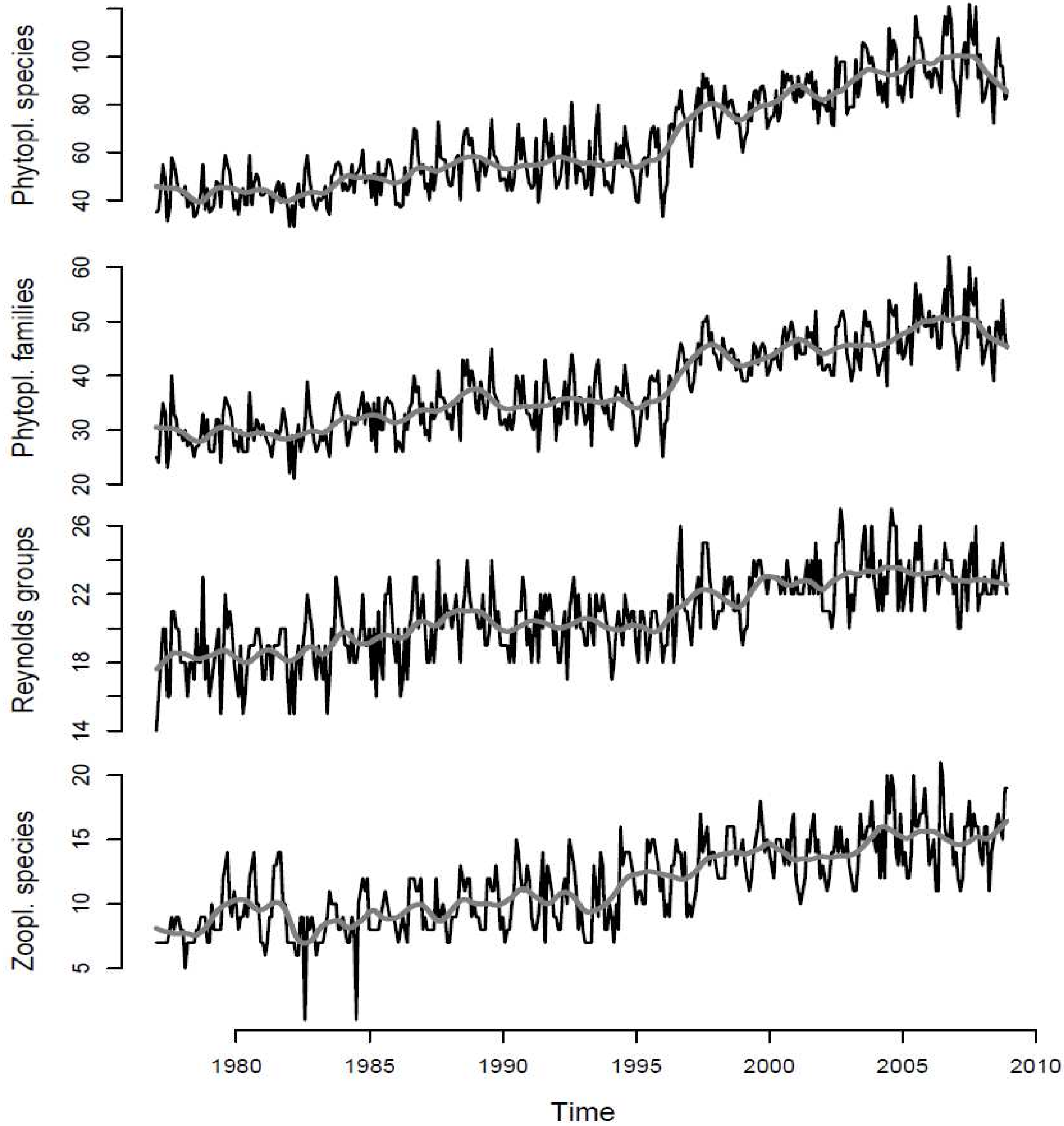
Francesco Pomati, Blake Matthews, Jukka Jokela, Andrea Schildknecht and Bas W. Ibelings

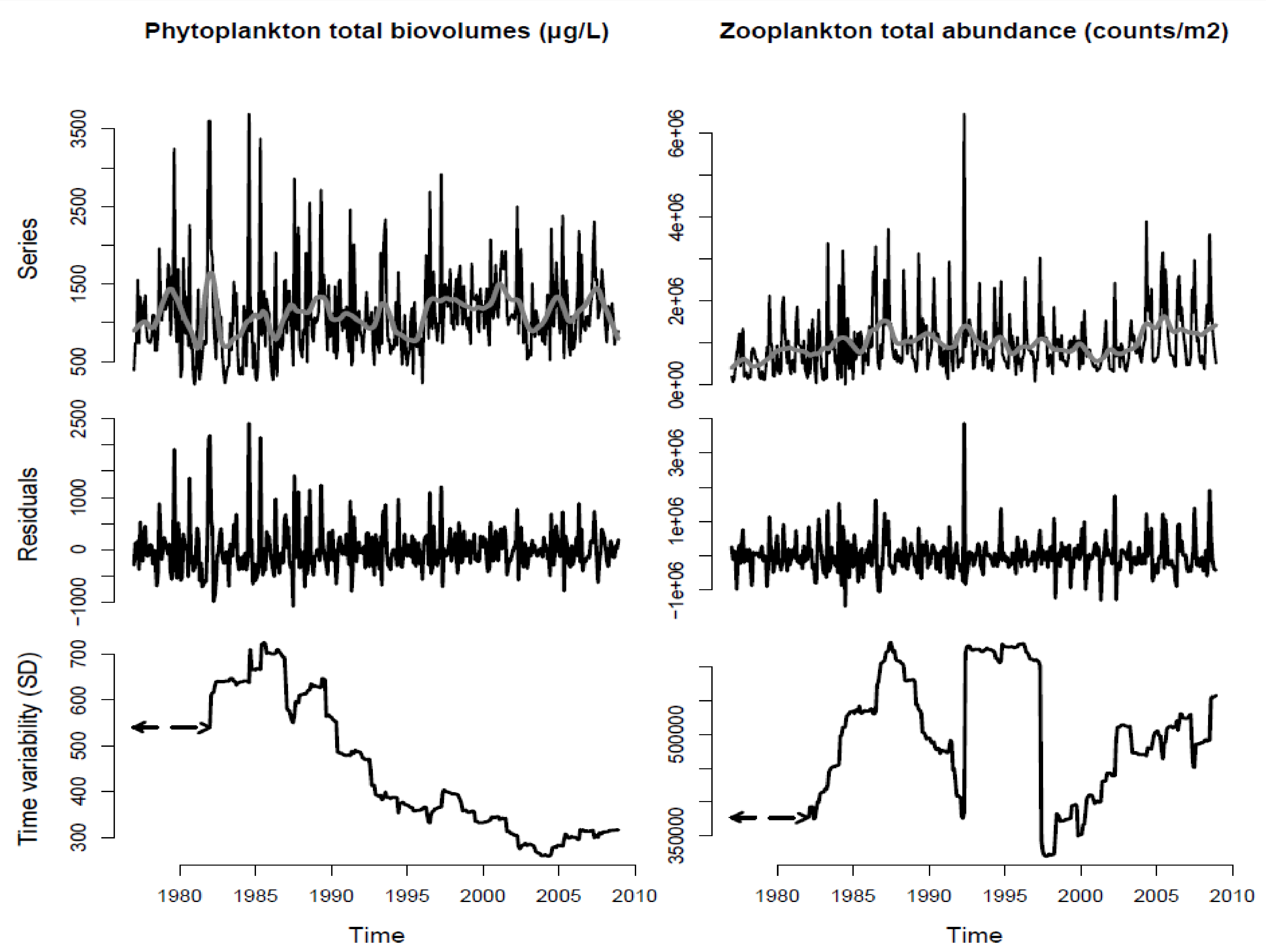
PCA of decomposed time series





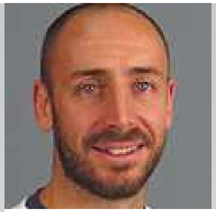
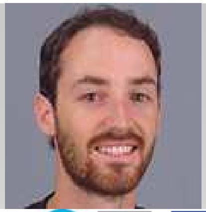
Temperature (°C)
P−PO4 (µg/L)
Series
Residuals
Time variability (SD)
Depth variability (CV)
Time
Time


Phytopl. species
Phytopl. families
Reynolds groups
Zoopl. species
Time
1980
1985
1990
1995
2000
2005
2010


Phytoplankton total biovolumes (µg/L)
Zooplankton total abundance (counts/m2)
Series
Residuals
Time variability (SD)
Time
500
1500
2500
3500
−1000
0
1000
2500
300
400
500
600
700
0e+00
2e+06
4e+06
6e+06
−1e+06
1e+06
3e+06
350000
500000
1980
1985
1990
1995
2000
2005
2010

take home

Increased spatial heterogeneity in Lake Zurich as a result of long term environmental change – re-oligotrophication linked to climate warming – has supported a strong accrual of phytoplankton diversity, leading to a more productive and more stable community of these primary producers.


eawag aquatic research 1936-2011

FNSNF
FONDS NATIONAL SUISSE
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

thank you…

for your time, patience and attention