DTO-BioFlow
Integration of biodiversity monitoring data into the Digital Twin Ocean

Changes of phyto- and zooplankton diversity and biomass in a eutrophic Baltic lagoon over decades

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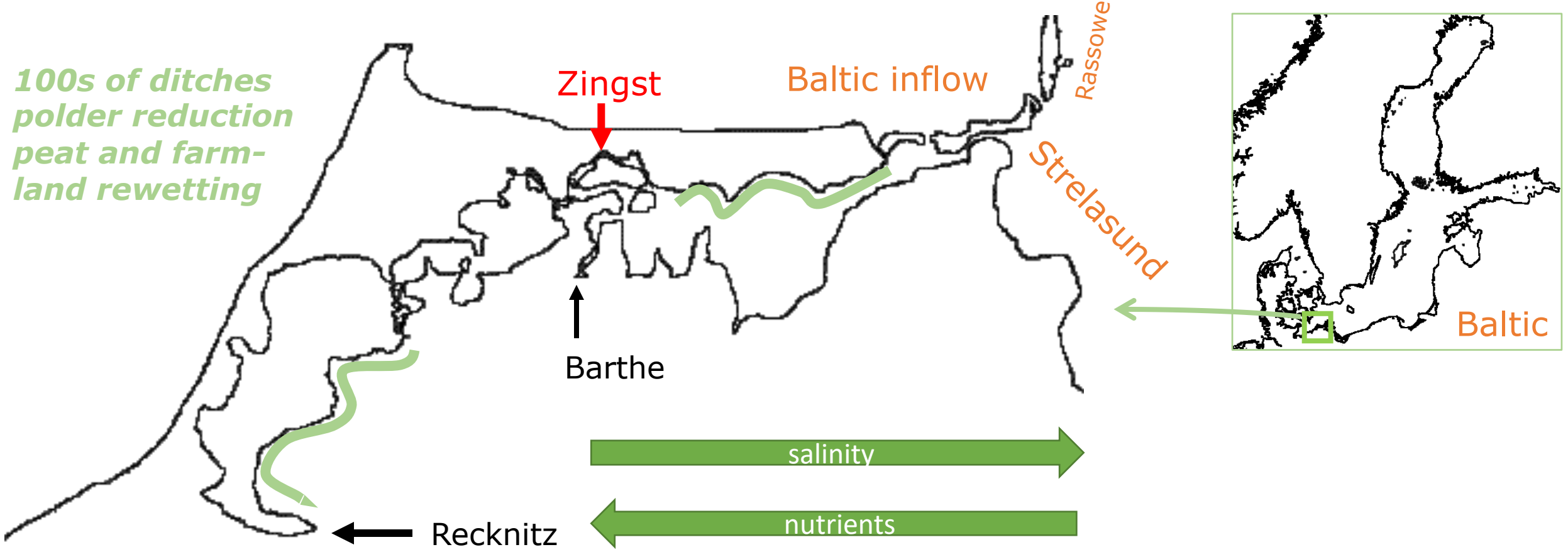
Lagoon at the Southern Baltic

area	170 km^2
Zingster Strom	3 km^2
longest distance	60 km
Salinity	2-12 PSU
Secchi	10-150 cm

Average concentrations

POC	9.3 mg l^{-1}	775 µM
TN		176 µM
TP		2 µM



Schumann et al. 2006

Data set

Organism group	Start-End	Frequency	Coverage (area)	Level
Bacterioplankton	1990-	weekly-biweekly	1	only total abundance
Phytoplankton	1969-1990	monthly, not every year	6	genus and species (microscopy)
	2006-2007	monthly	7	
	1991-	weekly-biweekly	1	+isolates of green algae, cyanobacteria, genetic information
Zooplankton	1969-1990	monthly	1	genus and species, stages 6 total
	1991-	weekly-biweekly	1	

+meiobenthos, macrozoobenthos, fishes: raw data not available

Data set

Abiotic	Nutrients	Elements	Atmospheric deposition	Wheather
water level	ammonium	DIC	pH	temperature
water temperature	nitrite	DOC	ammonium	precipitation
Secchi depth	nitrate	POC	nitrite	humidity
absorption (380nm)	phosphate	PN	nitrate	wind direction and velocity
scattering (720 nm)		TN	phosphate	air pressure
suspended matter		TP	TN	solar radiation
salinity			TP	photosynthetic active radiation
pH				
oxygen saturation				
plankton respiration				
attenuation				
chlorophyll a				

Different starting points and frequency at **Zingster Strom**

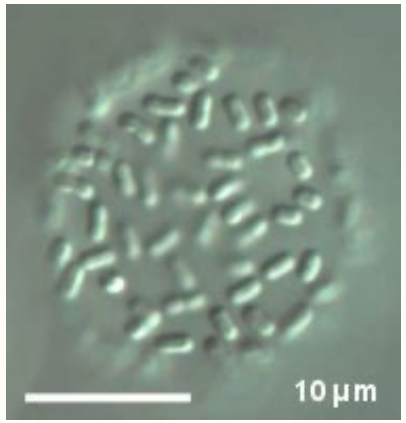
- 1969-1980: weekly to monthly
- since 1980: daily to weekly
- since 2000: online, at least every 10 min

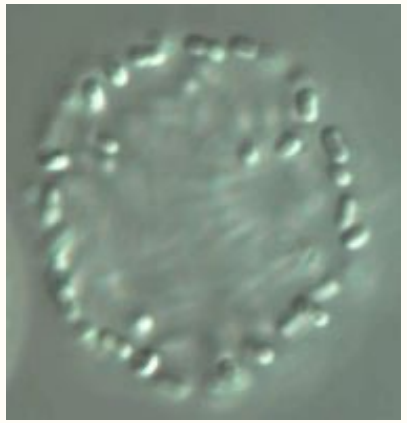
Gradient with 6-9 stations

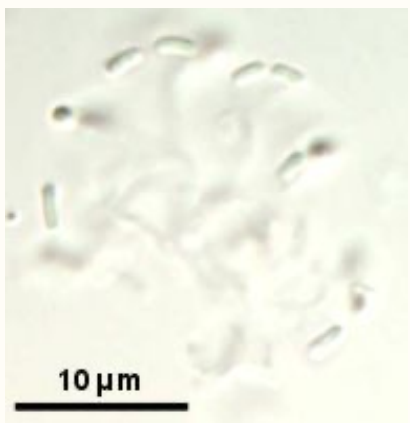
- always monthly

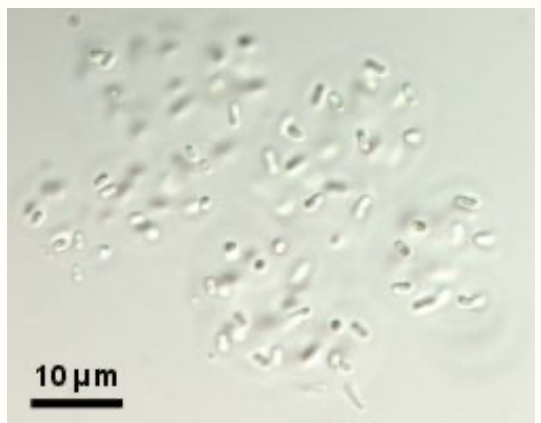
Synechococcales

mostly Cyanobium

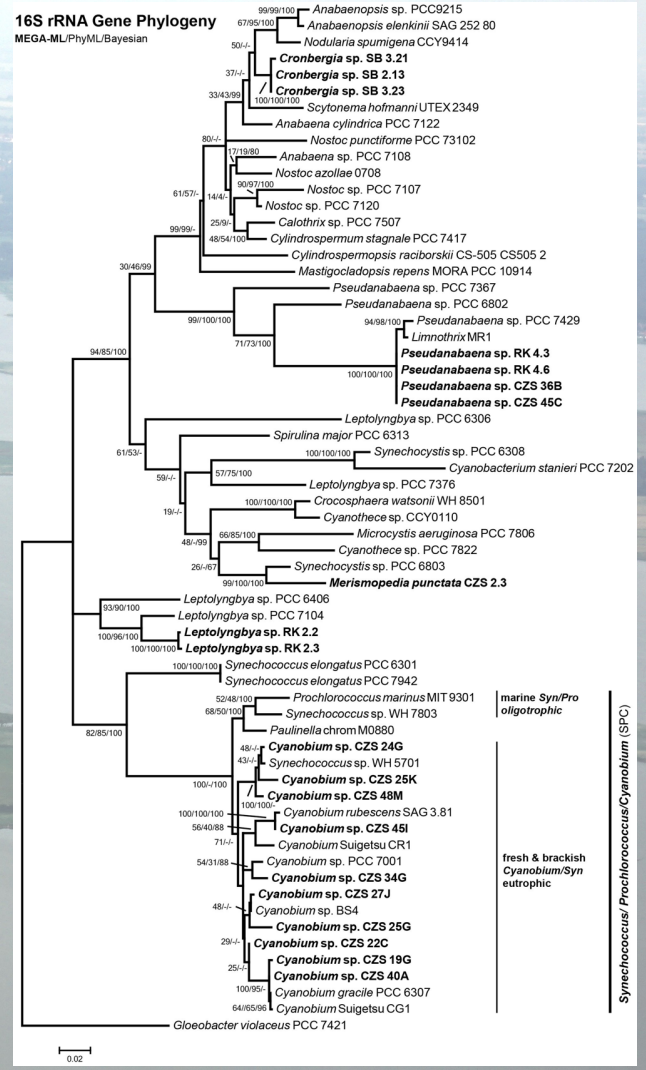






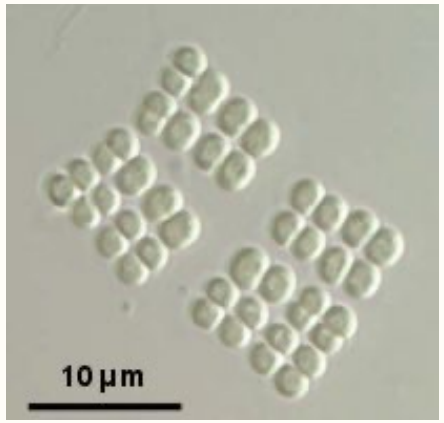


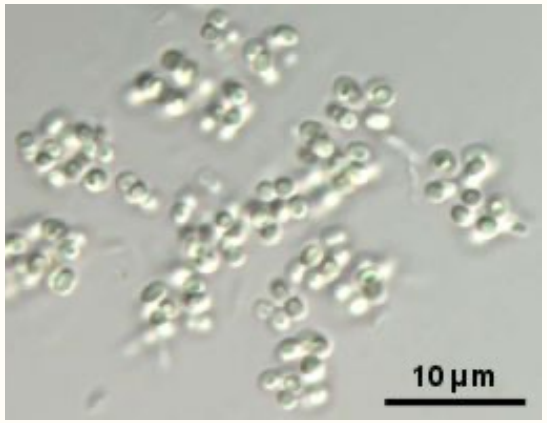
„Lemmermanniella pallida" *„Cyanonephron styloides"* *„Aphanothece clathrata"*



Chroococcales

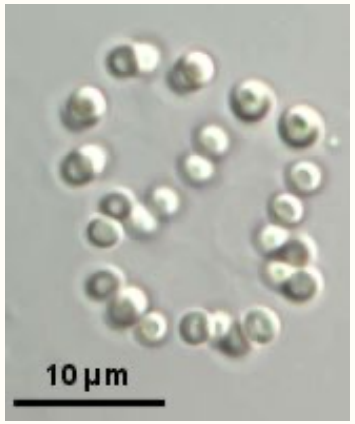
Merismopedioidae

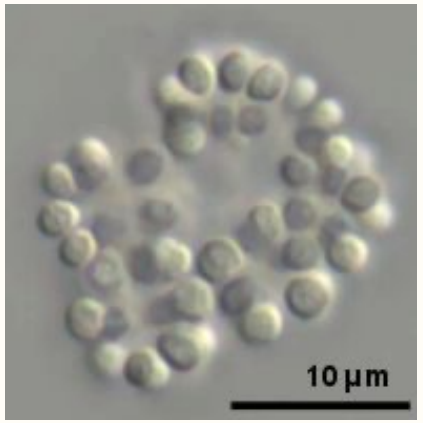




M. punctata *„Aphanocapsa* spec."

Gomphosphaerioidae



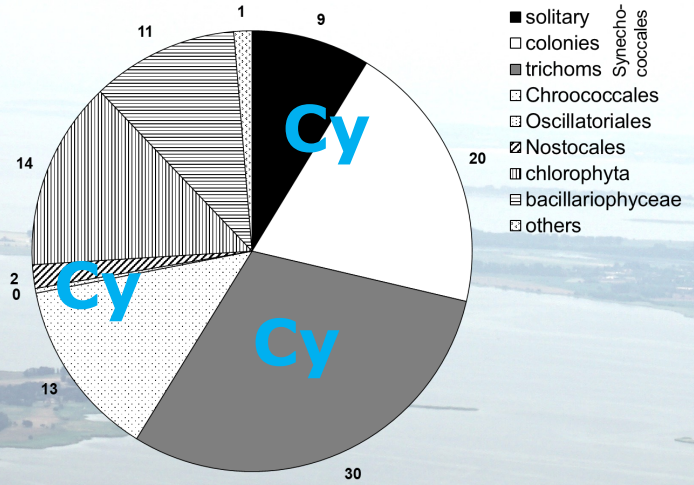


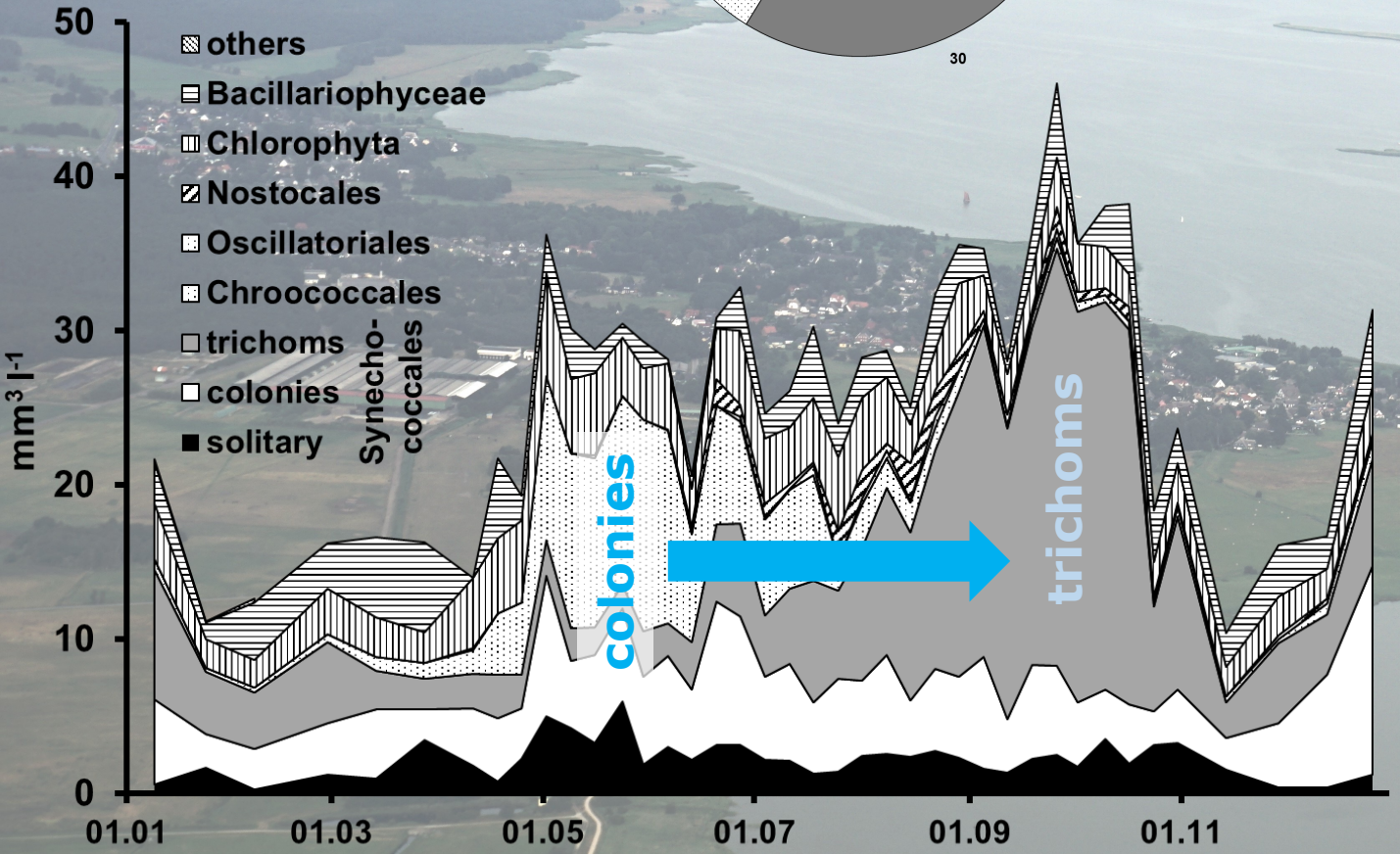
S. septentrionalis *W. compacta*

Albrecht et al. 2017

Annual cycle 2007

>75%
Cyanobacteria,
most not toxic,
not N-fixing



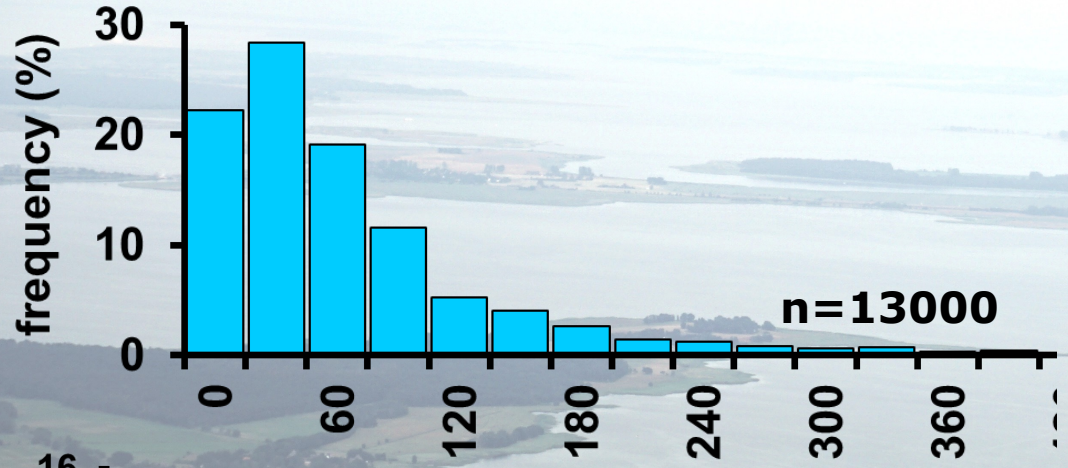


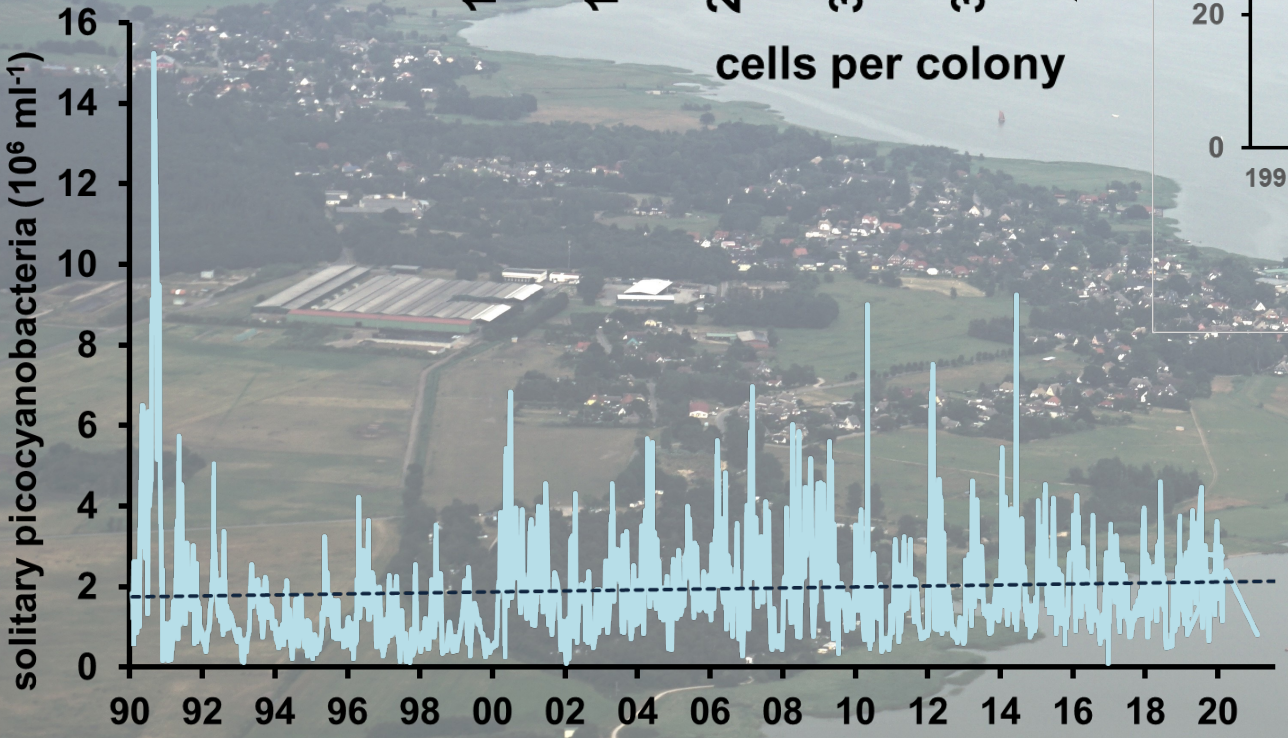
Sample results

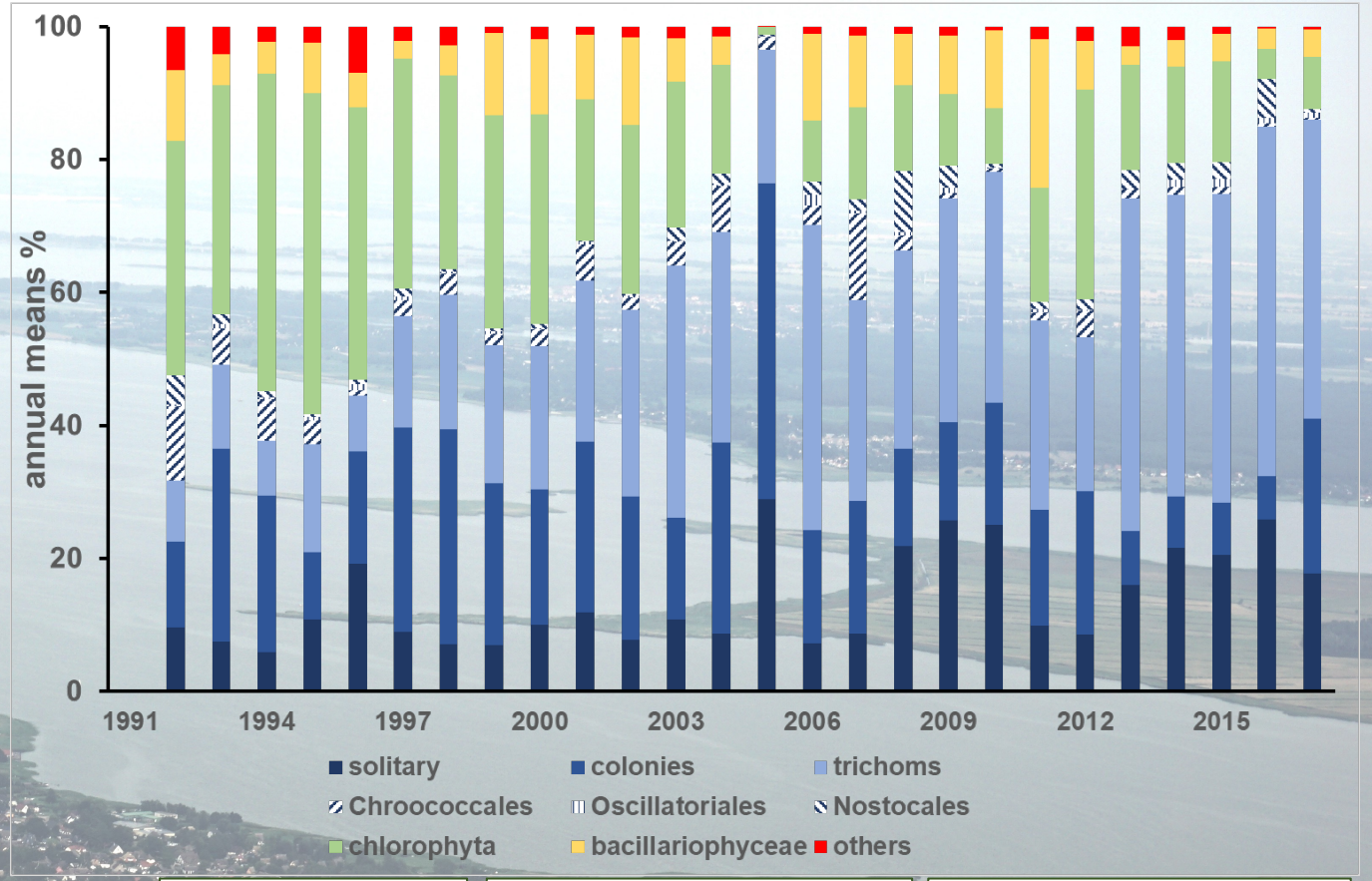
Datum: 12.05.2010 Probe : Zingster Strom

Art:	Körper	Länge	Breite	Höhe	Zellvolumen (µm³)	Eingabe: Zellen o. TS	Eingabe: Kolonien o. Fäden	Ausgabe: Zellen 10^6 l⁻¹	Ausgabe: Kolonien o. Fäden =10^3 ml⁻¹	Zellen/Kolonie o. Fadenlänge µm	Biovolumen mm³l⁻¹	Biomasse mg l⁻¹	mg C l⁻¹	Mikroskop	Objektiv	Verdünnung	Kammer	gesamte Kammer	Felder	Teilfelder	Faktor	ausgezähltes Volumen ml
														Euromex								
Aphanothece Komplex	S				0,787		98	3252,15	51,62	63	2,56	2,66	0,299	x	16	2	I	12	0,25	0,52675	0,002
Merismopedia punctata	K	2				4	1	0,37	0,09	4	0,00	0,00	0,000	x	16	2	I	17	1	0,09296	0,011
Merismopedia warmingian	K	1,5				4	1	0,37	0,09	4	0,00	0,00	0,000	x	16	2	I	17	1	0,09296	0,011
Microcystis v. Komplex	K	2					3	78,22	1,58	49,5	0,33	0,34	0,038	x	16	2	I	12	0,25	0,52675	0,002
Snowella spp.	K				8,082		2	30,55	1,05	29	0,25	0,26	0,029	x	16	2	I	12	0,25	0,52675	0,002
Synechococcus spp.	S				0,856			1420,08			1,22	1,26	0,142								
Chroococcales								4781,74	54,44		4,35	4,52	0,509								
Limnothrix planctonica	Z		2			4	2	0,77	0,19	13	0,01	0,01	0,001	x	16	2	I	17	1	0,09296	0,011
Planktolyngbya contorta	Z		2			1226	129	494,23	29,12	59	3,06	3,18	0,358	x	16	2	I	14	0,5	0,22575	0,004
Oscillatoriales								495,00	29,31		3,06	3,19	0,359								
Cyanobakterien								5276,75	83,75		7,41	7,71	0,867								
Desmodesmus opoliensis					400	4	1	0,01	0,00	4	0,00	0,00	0,000	x	10	2	I	1	1	0,00196	0,510
Monoraphidium Autosporen					100	4	1	0,37		4	0,04	0,04	0,004	x	16	2	I	17	1	0,09296	0,011
Monoraphidium contortum					100	26		2,42			0,24	0,25	0,028	x	16	2	I	17	1	0,09296	0,011
Monoraphidium minimum					50	20		1,86			0,09	0,10	0,011	x	16	2	I	17	1	0,09296	0,011
Oocystis spec.	R	8	6			2	1	0,19	0,09	2	0,03	0,03	0,003	x	16	2	I	17	1	0,09296	0,011
Pediastrum boryanum					500	48	2	0,09	0,00	24	0,05	0,05	0,006	x	10	2	I	1	1	0,00196	0,510
Scenedesmus ecornis					250	12	6	1,12	0,56	2	0,28	0,29	0,033	x	16	2	I	17	1	0,09296	0,011
Tetraedron minimum					150	10		0,93			0,14	0,15	0,016	x	16	2	I	17	1	0,09296	0,011
Chlorophyten								6,98	0,66		0,87	0,90	0,102								
Planctonema lauterbornii					100	2	1	0,19	0,09	2	0,02	0,02	0,002	x	16	2	I	17	1	0,09296	0,011
Ulvophyceen								0,19	0,09		0,02	0,02	0,002								
Diatoma elongatum	Q	15	6	6		1	1	0,09	0,09	1,0	0,05	0,05	0,007	x	16	2	I	17	1	0,09296	0,011
Diatoma vulgare	Q	12	8	8		4	3	0,37	0,28	1,3	0,29	0,30	0,039	x	16	2	I	17	1	0,09296	0,011
Diatoma vulgare	Q	8	8	8		11	11	1,02	1,02	1,0	0,52	0,54	0,072	x	16	2	I	17	1	0,09296	0,011
Navicula spec.	Q	12	5	3		1		0,09			0,02	0,02	0,002	x	16	2	I	17	1	0,09296	0,011
Sceletonema costatum	Z	12	4			4	2	0,01	0,00		0,00	0,00	0,000	x	10	2	I	1	1	0,00196	0,510
Stephanodiscus hantzschii	Z	4	6			23		2,14			0,24	0,25	0,033	x	16	2	I	17	1	0,09296	0,011
Stephanodiscus hantzschii	Z	6	8			10		0,93			0,28	0,29	0,038	x	16	2	I	17	1	0,09296	0,011
Stephanodiscus hantzschii	Z	6	10			5		0,46			0,22	0,23	0,030	x	16	2	I	17	1	0,09296	0,011
Stephanodiscus hantzschii	Z	15	20			2		0,00			0,02	0,02	0,003	x	10	2	I	1	1	0,00196	0,510
Diatomeen								5,12	1,40		1,64	1,70	0,225								
Plagioselmis acuta	R	8	4			3		0,28			0,02	0,02	0,002	x	16	2	I	17	1	0,09296	0,011
Cryptophyceen								0,28			0,02	0,02	0,0022								
Gymnodinium spec.	K	25				1		0,00			0,02	0,02	0,002	x	10	2	I	1	1	0,00196	0,510
Dinophyceen								0,00			0,02	0,02	0,0019								
Gesamt								5289,32	85,90		9,97	10,37	1,200								

Cyanobium group

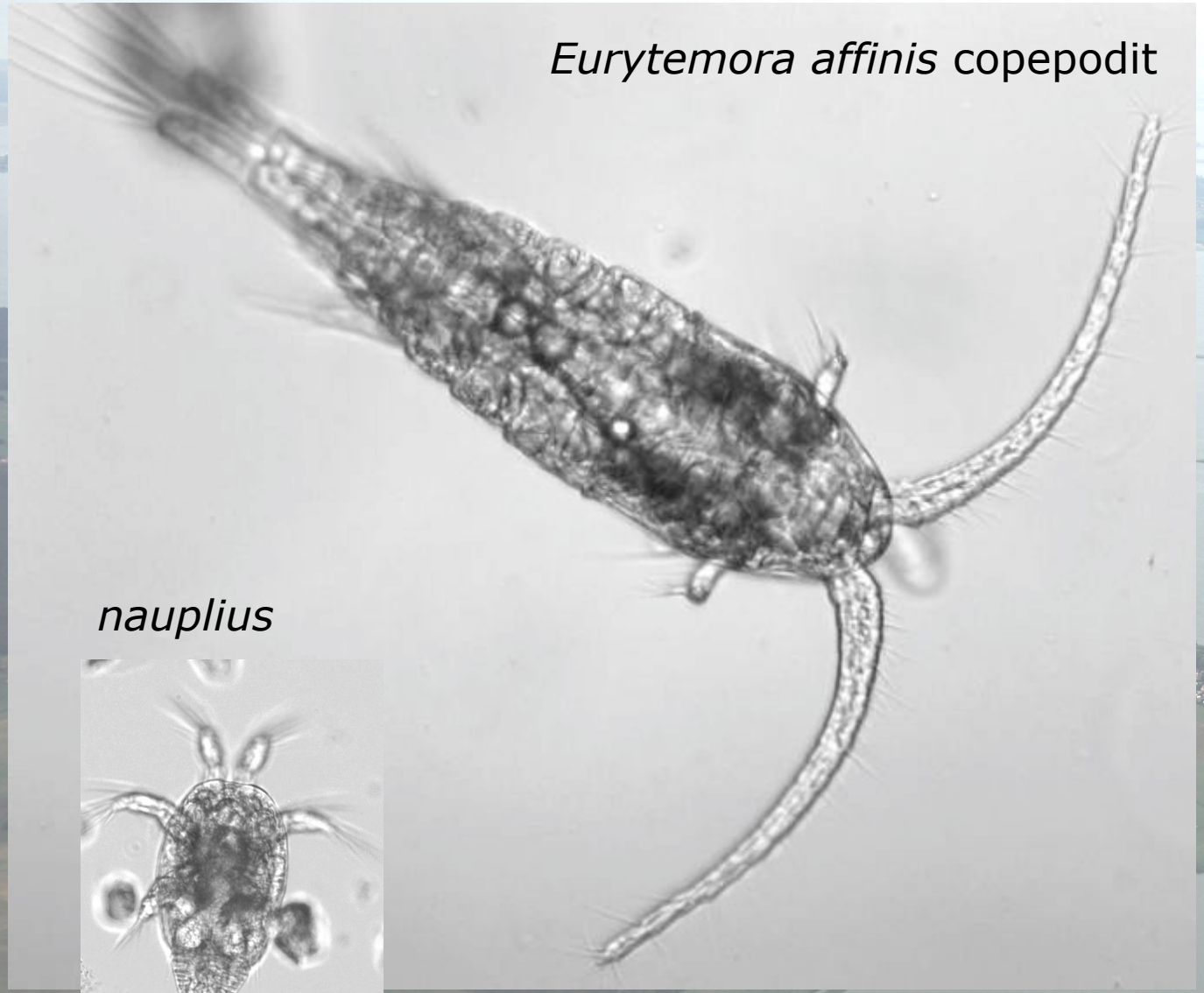






species	**morphotypes**	**categories**
61 cyano.	26 cyano.	183 total
2 chryso.	5 chryso.	30-40 per sample
257 diatoms	23 diatoms	
11 dino.	16 dino.	*incl. colony sizes*
87 chloro.	36 chloro.	*and filament lenght*
9 eugleno.	4 eugleno.	
0 crypto.	7 crypto.	

Schumann et al. in prep. Kell et al. 1976

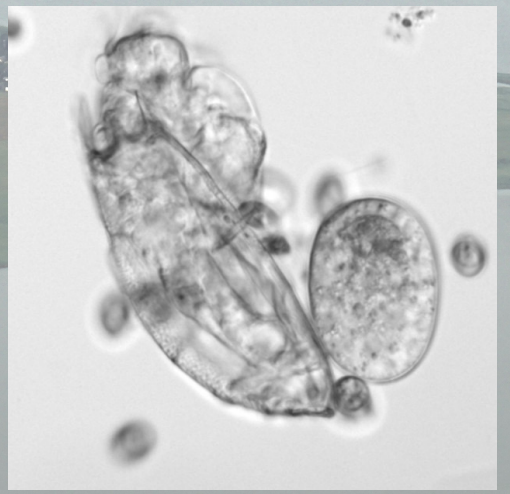


Eurytemora affinis copepodit

nauplius

Brachionus quadridentatus

Syncheata spec.



Keratella cf. *tecta*

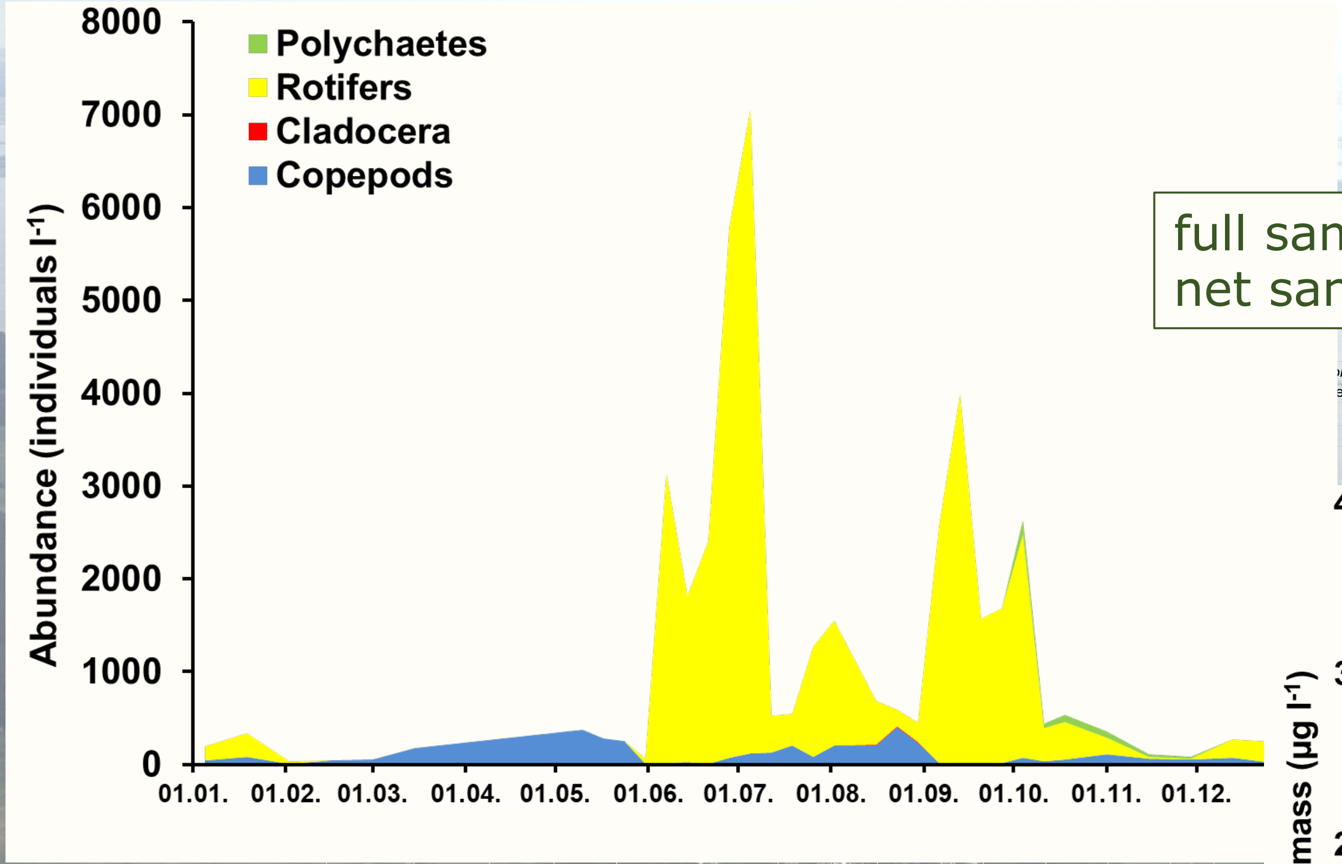
Calanoid copepods

Annual cycle 2016

Sample results

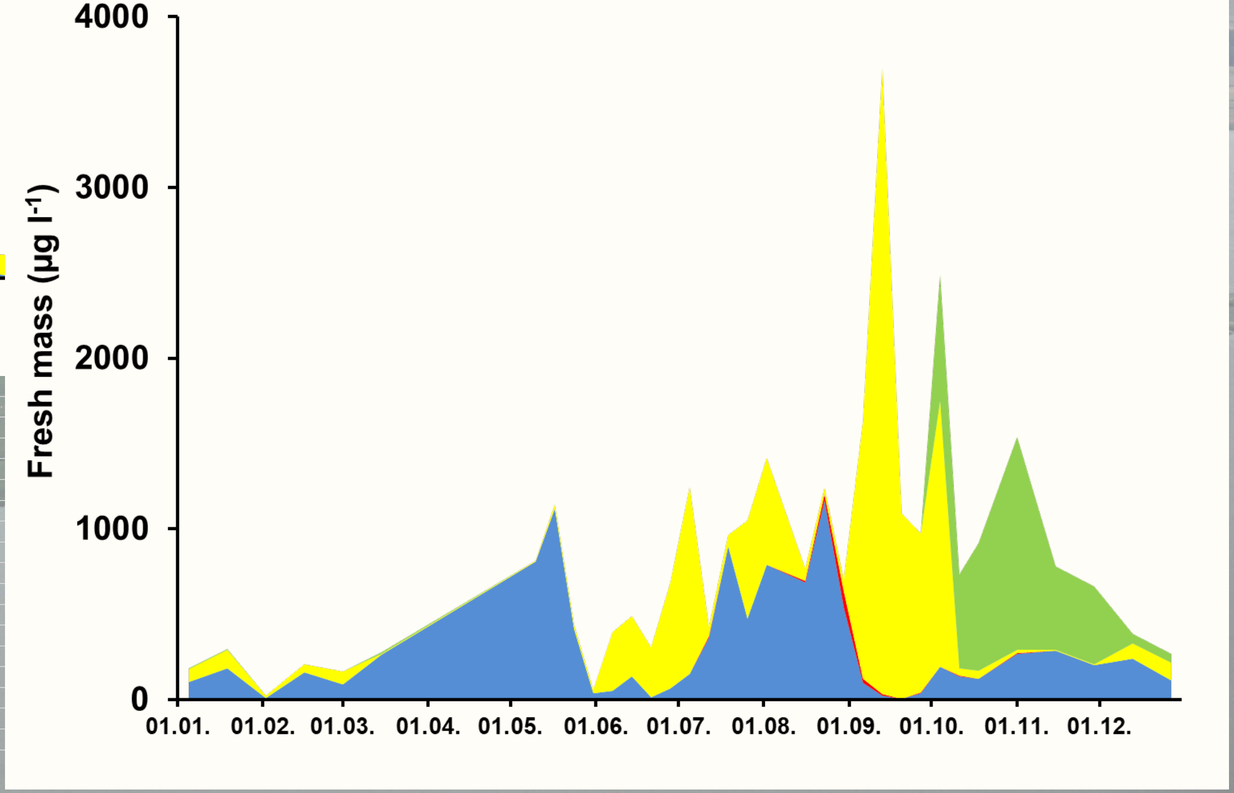
30 species / morphotypes
6 stages copepods
20 animals measured per sample

full sample: 1 l for rotifers and juvenile stages
net sample: 5 l for copepods, cladocera, other larvae

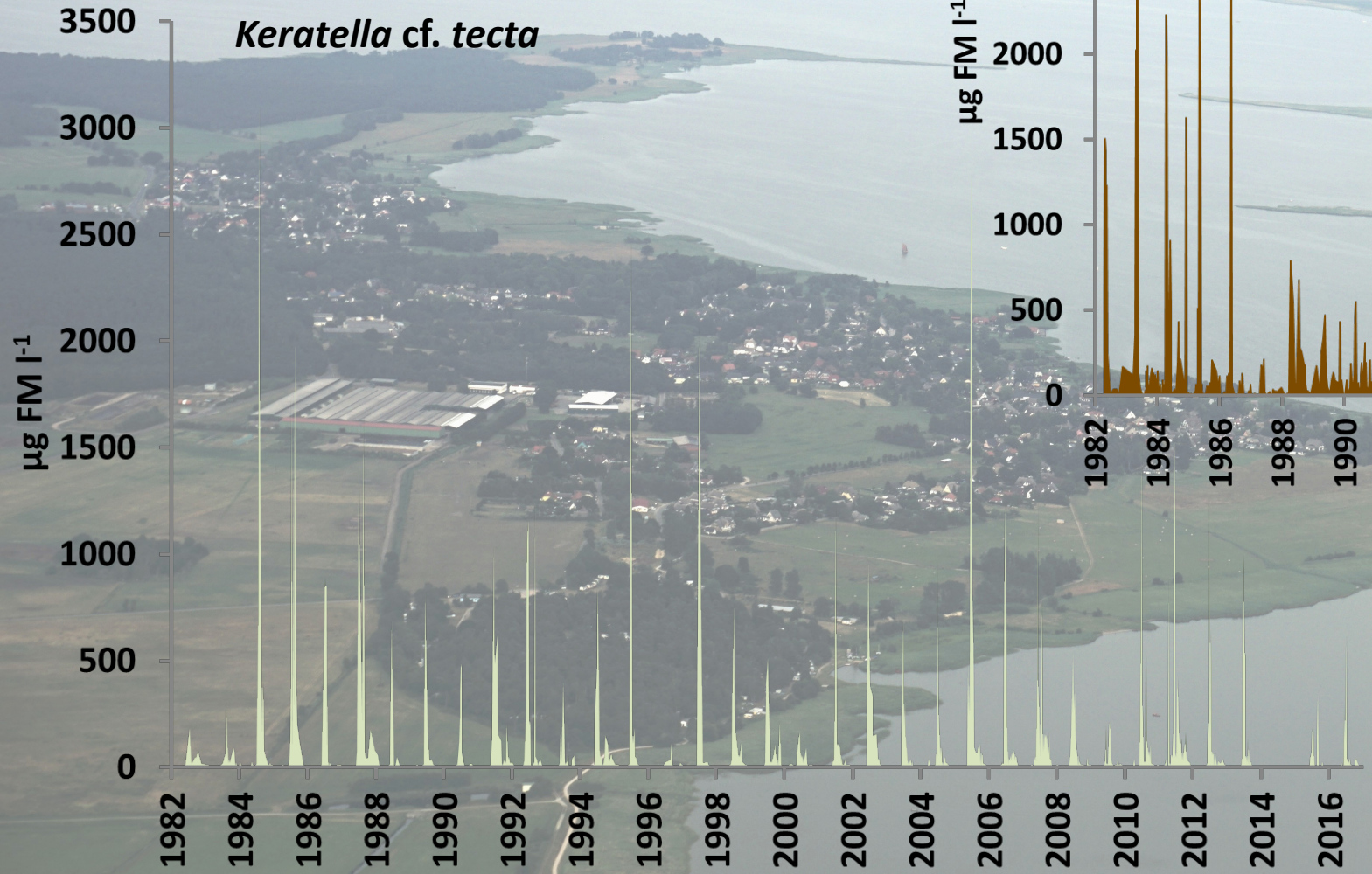


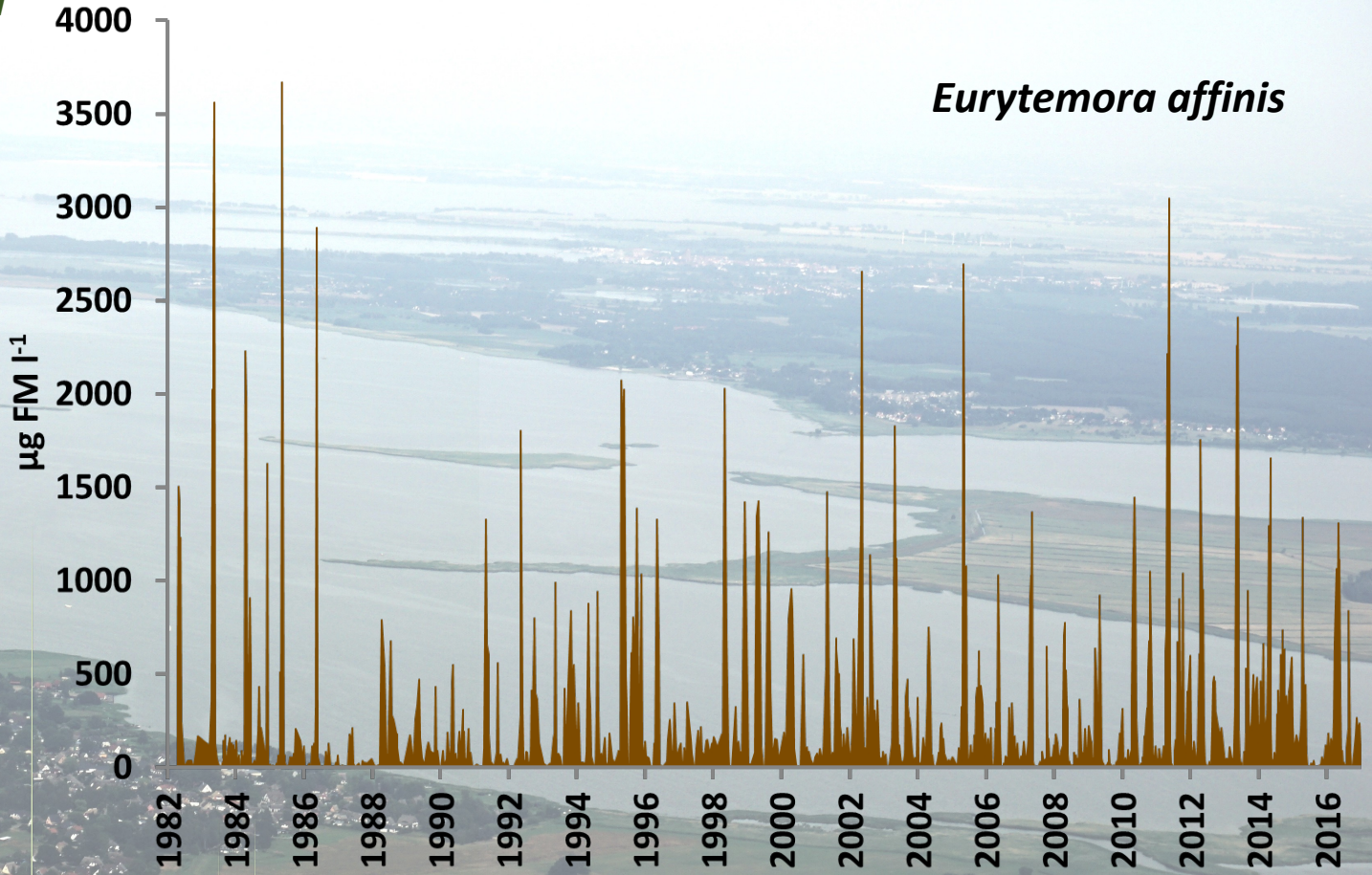
26.07.2016	1		0	1,8	7,92	1,4	11,9		0		0
02.08.2016	1		0	2,6	11,44	5,2	44,2	1,6	20,912	0,4	5,868
09.08.2016	1		0	5,2	22,88	6,8	57,8	1,6	20,912	1,4	20,538
16.08.2016	1		0	7	30,8	7,6	64,6	2,4	31,368	3,2	46,944
23.08.2016	1		0	18,2	80,08	31,2	265,2	7,8	101,946	14,0	205,38
30.08.2016	1		0	4	17,6	18,2	154,7	7,8	101,946	5,4	79,218
06.09.2016	1		0	0,8	3,52	2,6	22,1	1,6	20,912	2,6	38,142
13.09.2016	1	0,6	0,258		0		0		0		0
20.09.2016	1		0		0		0		0		0
27.09.2016	1		0		0		0		0		0
04.10.2016	1		0		0		0		0		0
11.10.2016	1		0	0,2	0,88		0		0	0,6	8,802
18.10.2016	1		0	2,8	12,32	1,6	13,6	1,2	15,684	0,8	11,736
01.11.2016	1		0	9	39,6	7	59,5	1,4	18,298	1,4	20,538
15.11.2016	1		0	7,6	33,44	13,2	112,2	3,6	47,052	3,4	49,878
29.11.2016	1		0	7,4	32,56	7,2	61,2	2,6	33,982	2,8	41,076
13.12.2016	1		0	3,88	17,072	8	68	3,6	47,052	5,0	73,35
27.12.2016	1		0	0,6	2,64	3,8	32,3	3,4	44,438	2,0	29,34

bbe															
en 1-3	0,43	Nauplien 4-6	1,47	Copepoditen 1-3	4,4	Copepoditen 4-6	8,5	Males	13,07	Females	14,67	Eggs	0,1	Animals	Biomass
	µg FM l^{-1}		µg FM l^{-1}		µg FM l^{-1}		µg FM l^{-1}		µg FM l^{-1}	11	µg FM l^{-1}		µg FM l^{-1}		µg FM l^{-1}
22	9,46	12	17,64	5	22		0		0		0		0	45,0	103,998
48	20,64	17	24,99	10	44	19	161,5	4	52,28	5	73,35		0	82,2	181,962
1	0,43	2	2,94	6	26,4	11	93,5	2	26,14	2	29,34		0	4,0	10,23



Dominating Eurytemora and Keratella





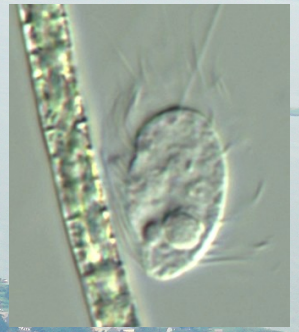
total biomass
ca. 10% compared to phytoplankton

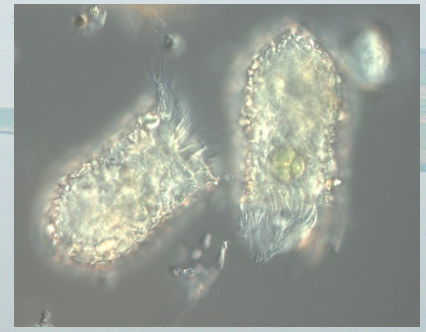
Dominant cyanobacteria Synechococcales

- low grazing loss
- adaptation to low and changing light conditions
- cause poor underwater light climate (ca. 40% euphotic zone)
- high competition strenght for nutrients
- stable community for > 3 decades

Dominant rotifers and poor crustacean diversity

- low grazing pressure on phytoplankton
- dominance of different rotifers
- more cyclopoid copepods since 2018
- rare cladocera






Open questions

- When and why did this dominance established?
- When and how can the cyanobacterial dominance be terminated?
- Why zooplankton groups have a clear seasonality unlike their food?
- Why is the grazing pressure so low (<15% of standing stock)?
- How can phytoplankton persist in winter?
- Importance of planktonic heterotrophic protists?