Micromonas project meeting
January 2010

Alexandra Z. Worden

Monterey Bay Aquarium Research Institute

Microbial oceanography

Urgency

Mechanistic knowledge of marine carbon-cycle is weak

Very diverse microbial communities – bacteria, archaea and protists

Many uncultured; interactions not known

Today –

Project rationale/goals

Introduction to *Micromonas*

ALEX MOVE
THIS: 10+ years behind *Chlamy*/Plant

OCEANS

Picoplankton Do Some Heavy Lifting

<2-3 μm diameter

Tiny unicellular plants called picoplankton play an unexpectedly large role in the transport of organic matter to the deep ocean.

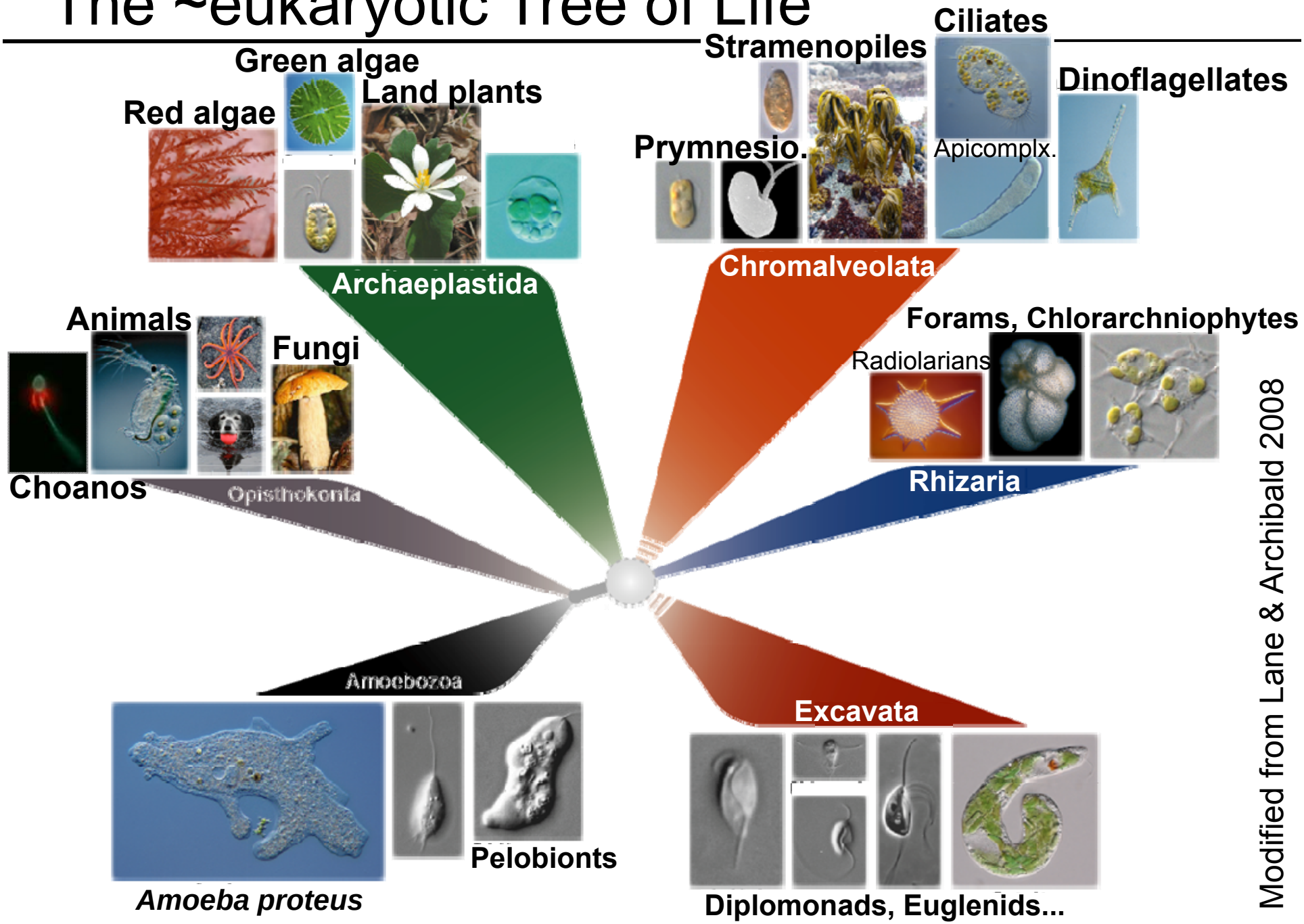
Richardson & Jackson *Science* 2007

Prochlorococcus
Synechococcus
] Cyanobacteria

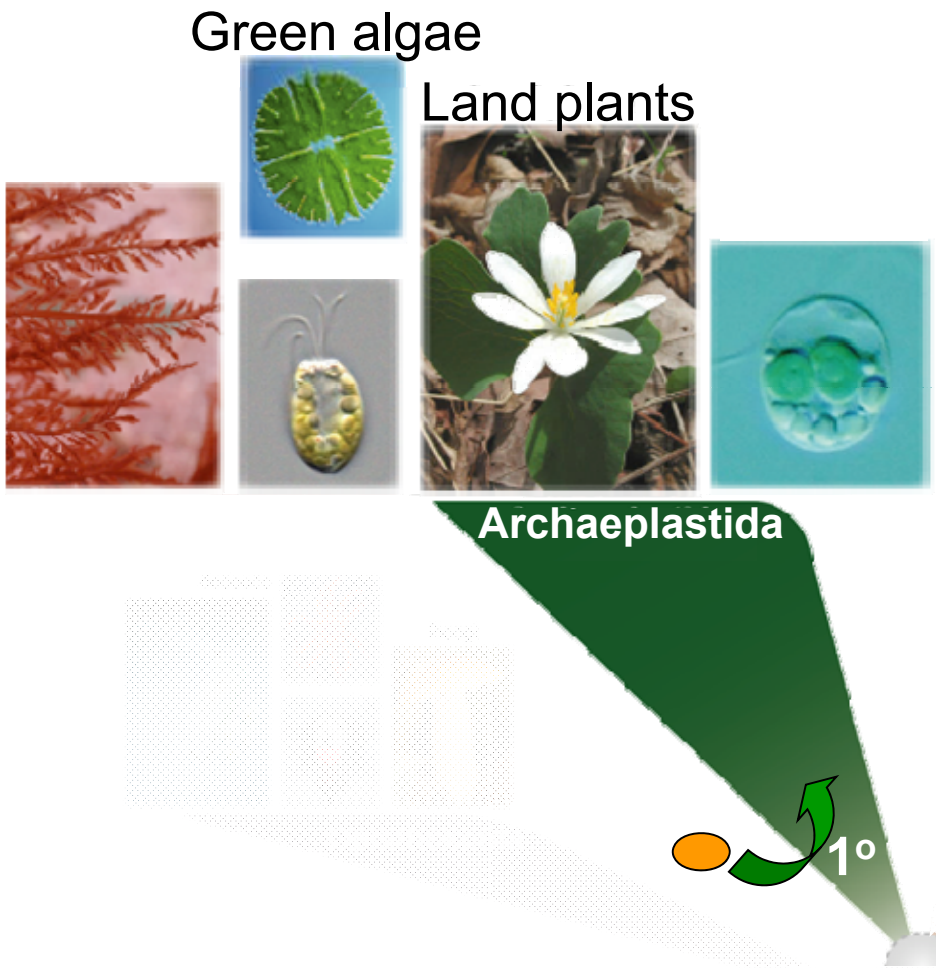
Picophytoeukaryotes,
e.g. *Micromonas*

Bill Li's arctic results

The ~eukaryotic Tree of Life



Modified from Lane & Archibald 2008



Ancestral green algae were of fundamental importance to the eukaryotic ‘greening’ that shaped Earth ecosystems

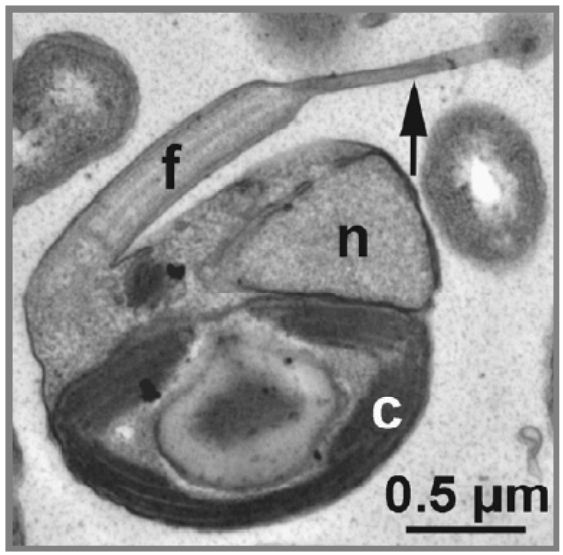
Persistence in modern oceans

pico-prasinophytes

Ostreococcus

Worden et al. 2004

Micromonas



Worden et al. 2009

Ostreococcus ~ 13 Mb genome (Derelle et al '06, Palenik et al '07)

Micromonas (2 isolates) ~ 21 Mb each } CCMP1545 & RCC299

(*Chlamy* ~ 120 Mb)

Pros: Reduced genomes, low redundancy, few repeats

Cons: No genetic system (overcome this w/RNAseq & RNAi?)

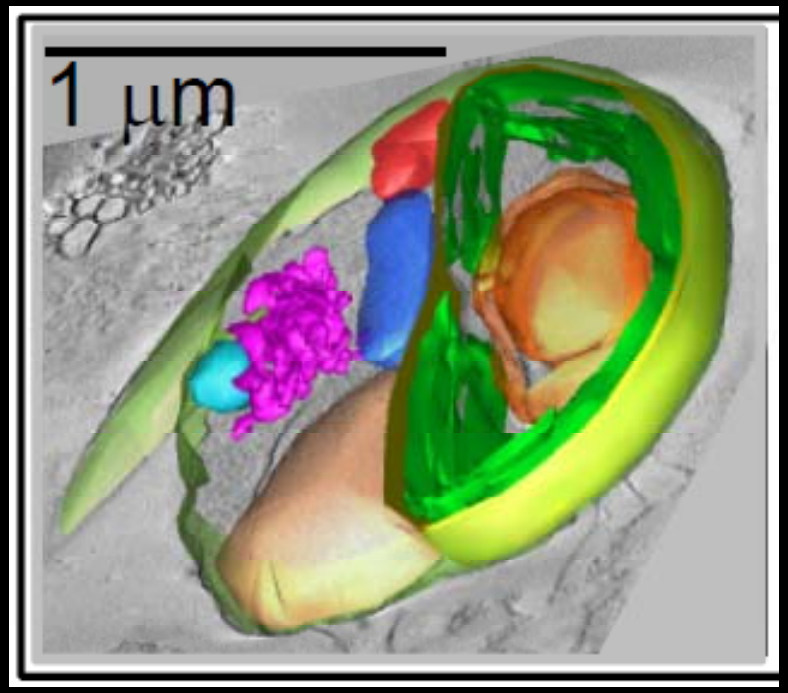
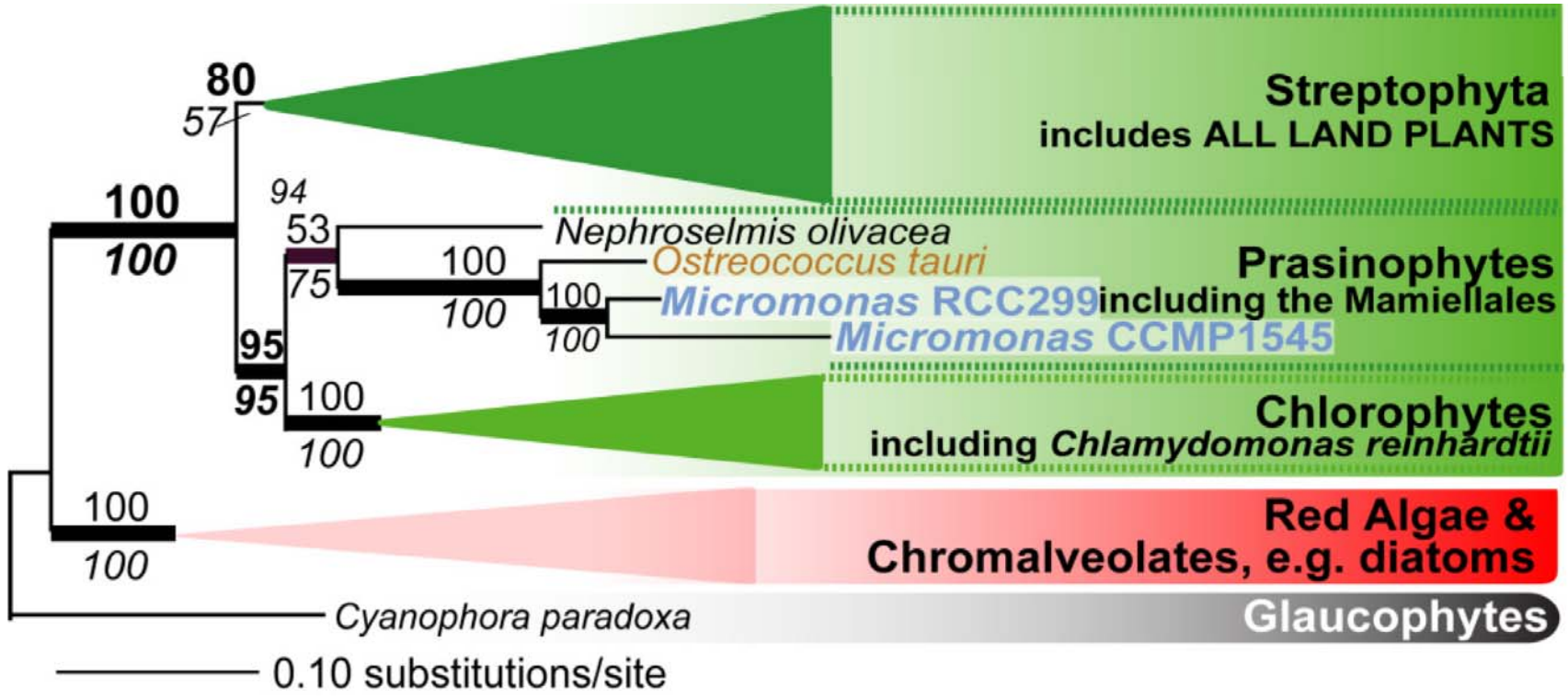


Image: Worden Deerinck, Terada, Oniyashi & Ellisman

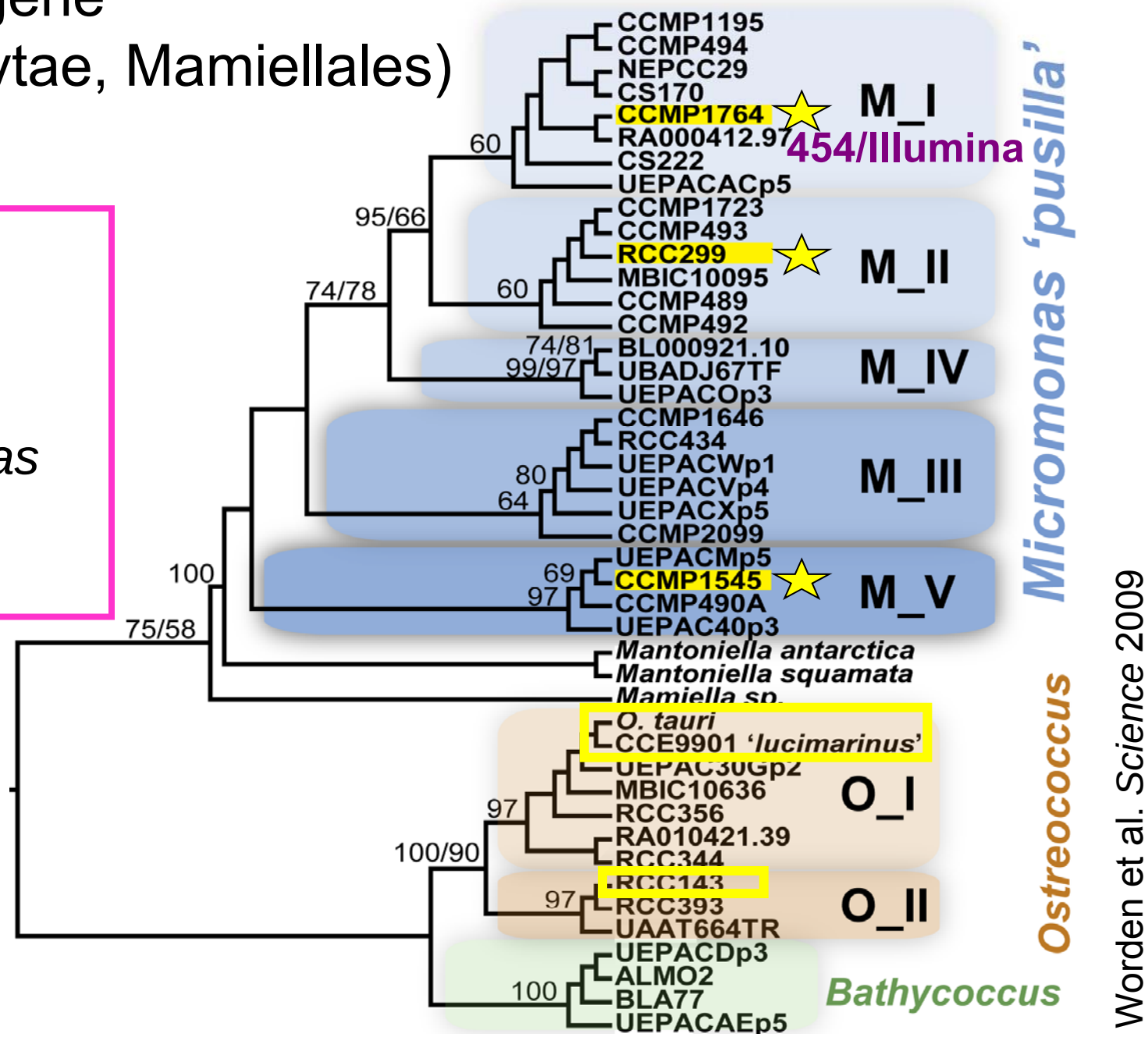
Phylogenetic relationships



18S rRNA gene (Prasinophytae, Mamiellales)

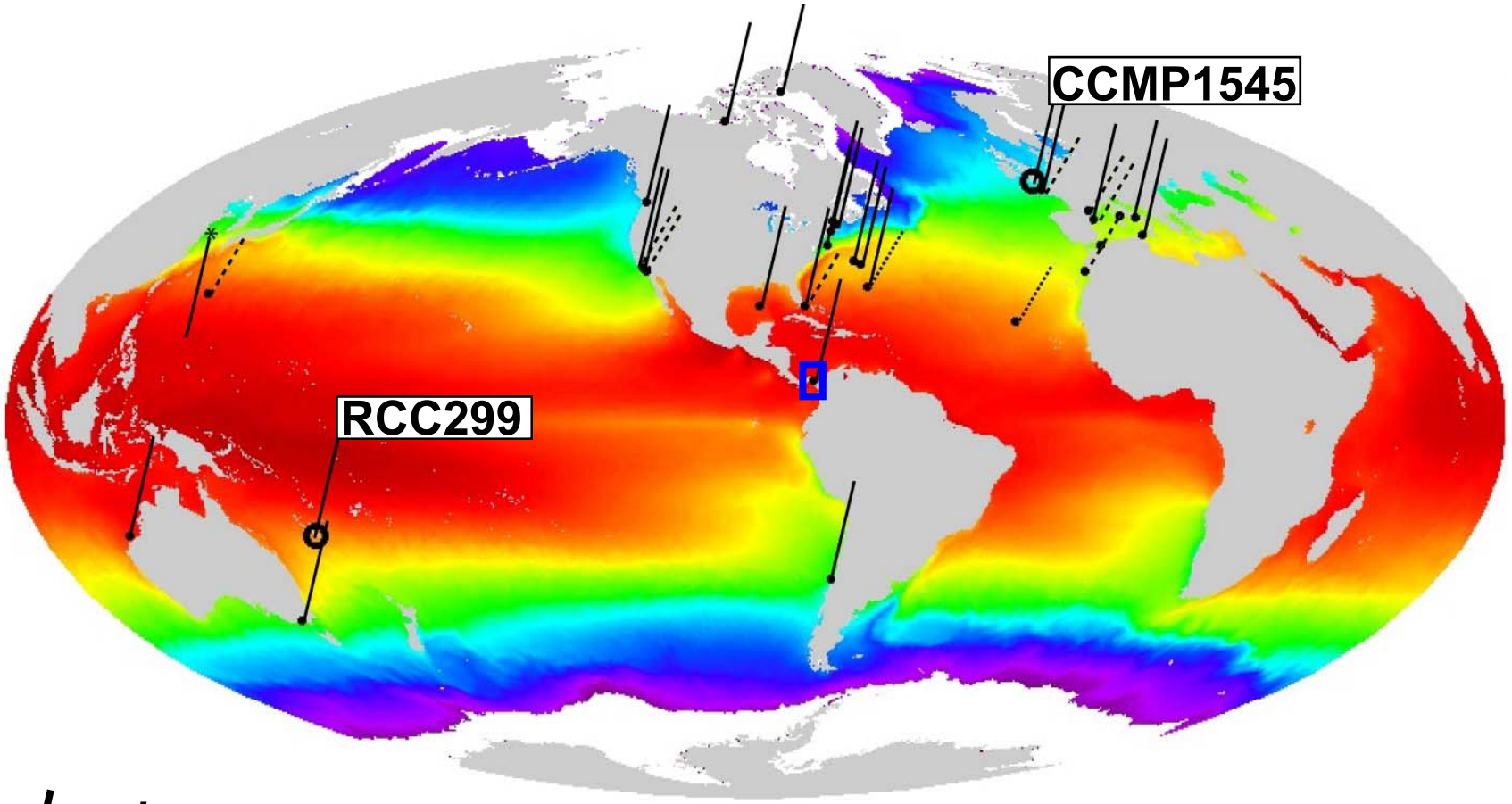
Cryptic species??

Multiple *Micromonas* clades co-exist



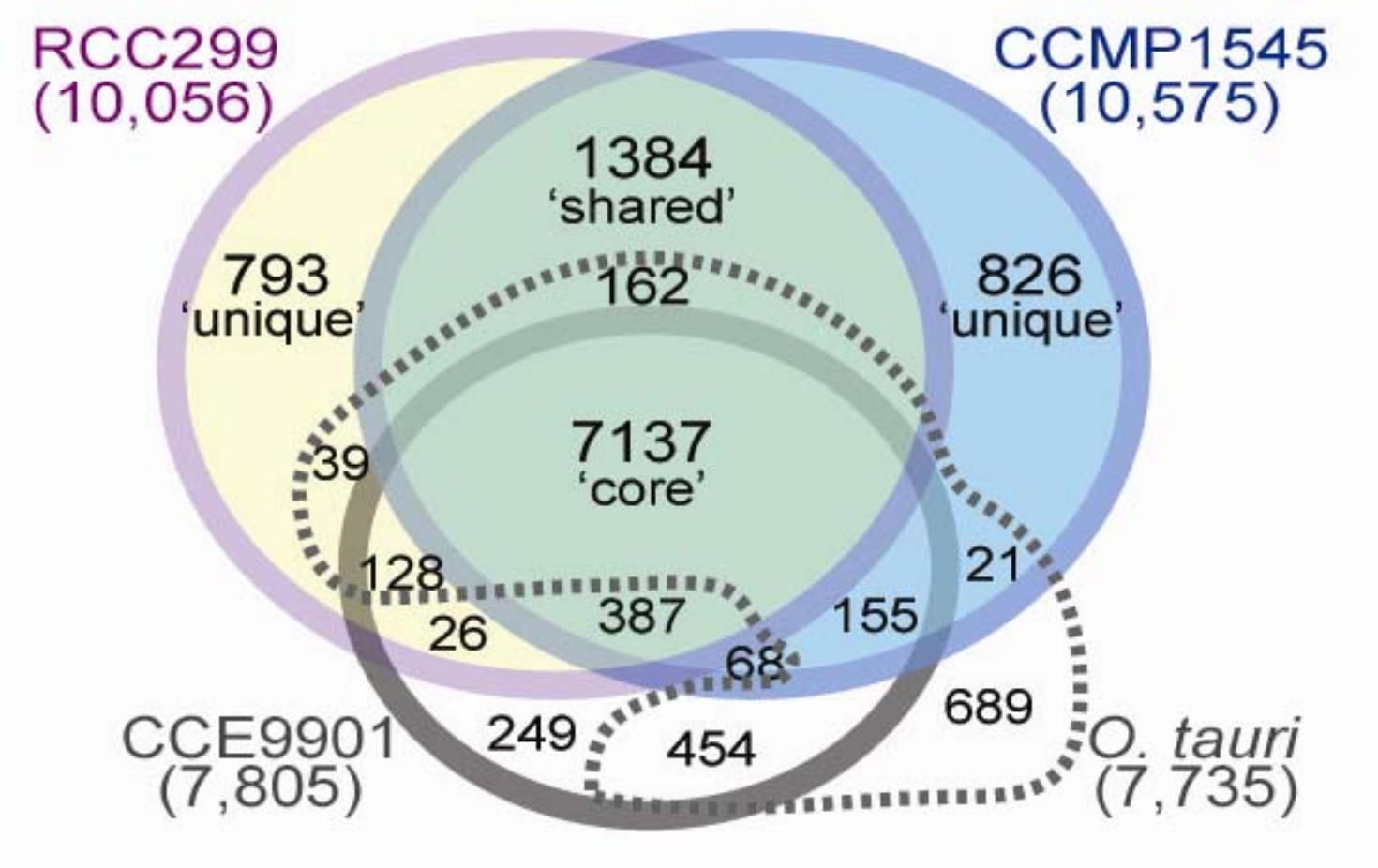
Worden et al. *Science* 2009

Micromonas is globally distributed



At most 90% of genes shared by *Micro* strains

'Unexpected' divergence for same eukaryotic 'species'



97% 18S rDNA identity

Worden et al. *Science* 2009

Insights to co-existence?...differentiation?

‘unique’
RCC299 or CCMP1545

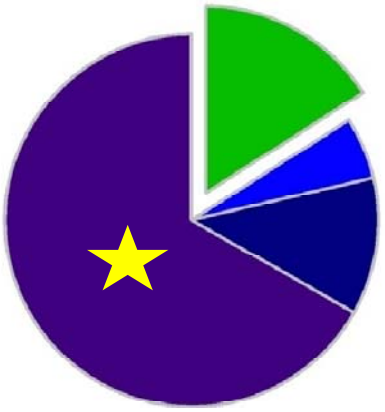
most ‘uniques’ affiliate with:
Chromalveolates, Opisthokonts & Bacteria

Transport

‘shared’ in Micro
but not Ostreo

Cell motility

‘core’
all Mamiellales



Sex

most ‘core’ affiliate with:
other Green Lineage Orgs.

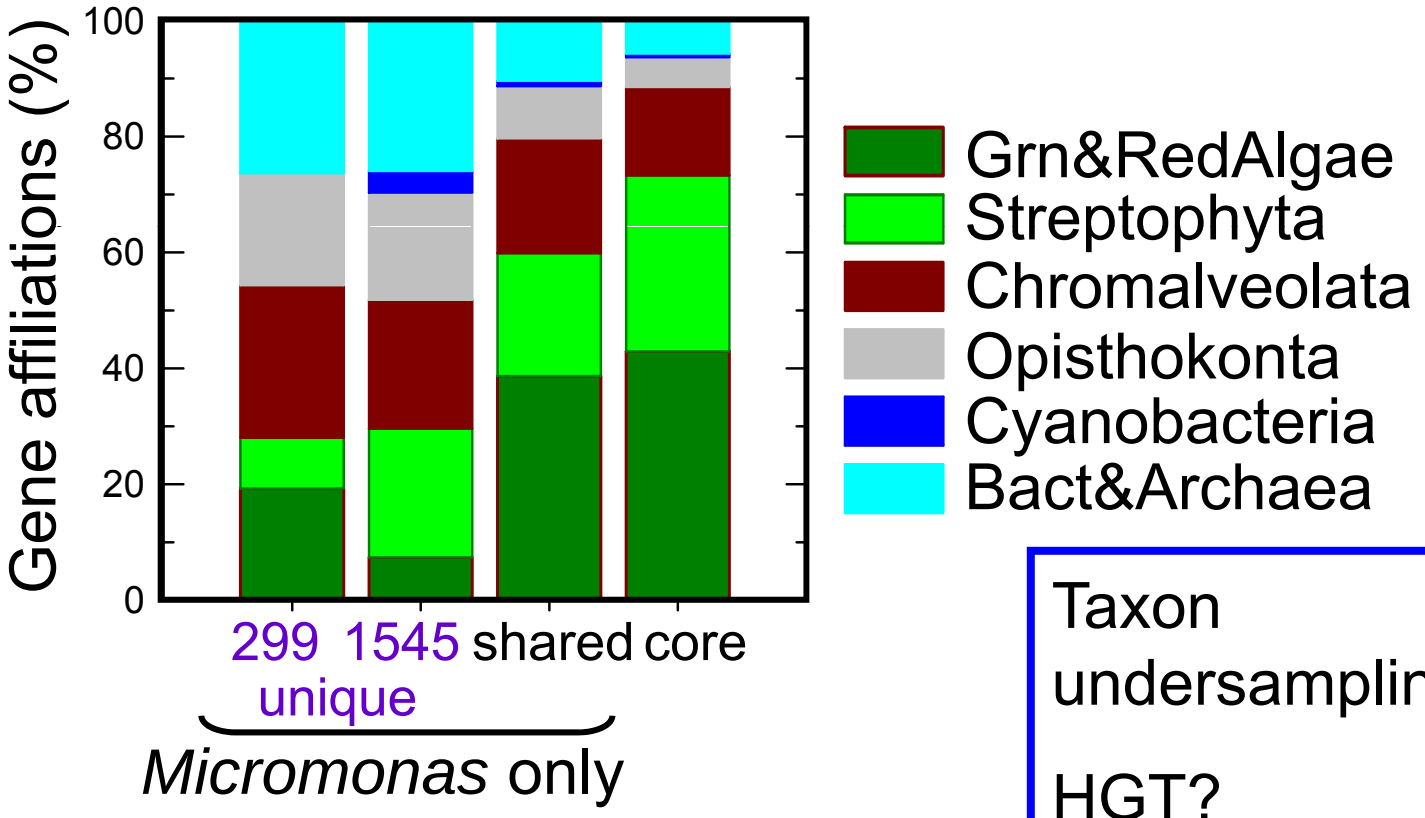
EuKaryotic Orthologous Groups (KOGs)

Known Function
General Function
Unknown Function
No Orthologous Group

KOG bearing

Mixed lineage affiliations – a trend

also seen in diatoms



Taxon undersampling?

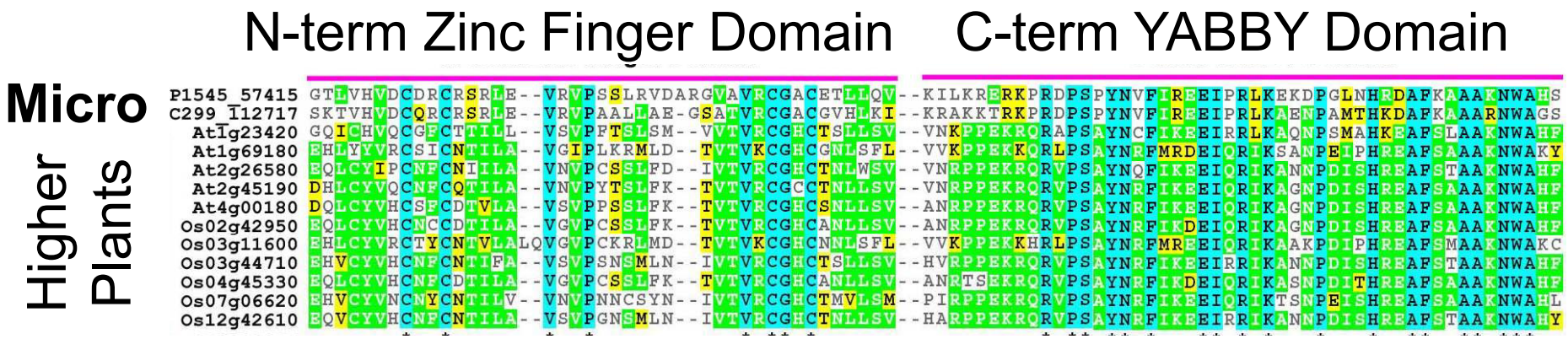
HGT?

Loss/divergence?

collaboration w/Allen & Badger in Worden et al. *Science* 2009

Reconstructing the ancestor

YABBY



The potential importance of cooption…

Also see genes implicated in obesity, breast cancer, etc.

An indication of degree of taxon undersampling?

Would less reduced algal genomes tell more about ancestor?

Worden et al. *Science* 2009

Ecological considerations

>Primed for life in low nutrient environments

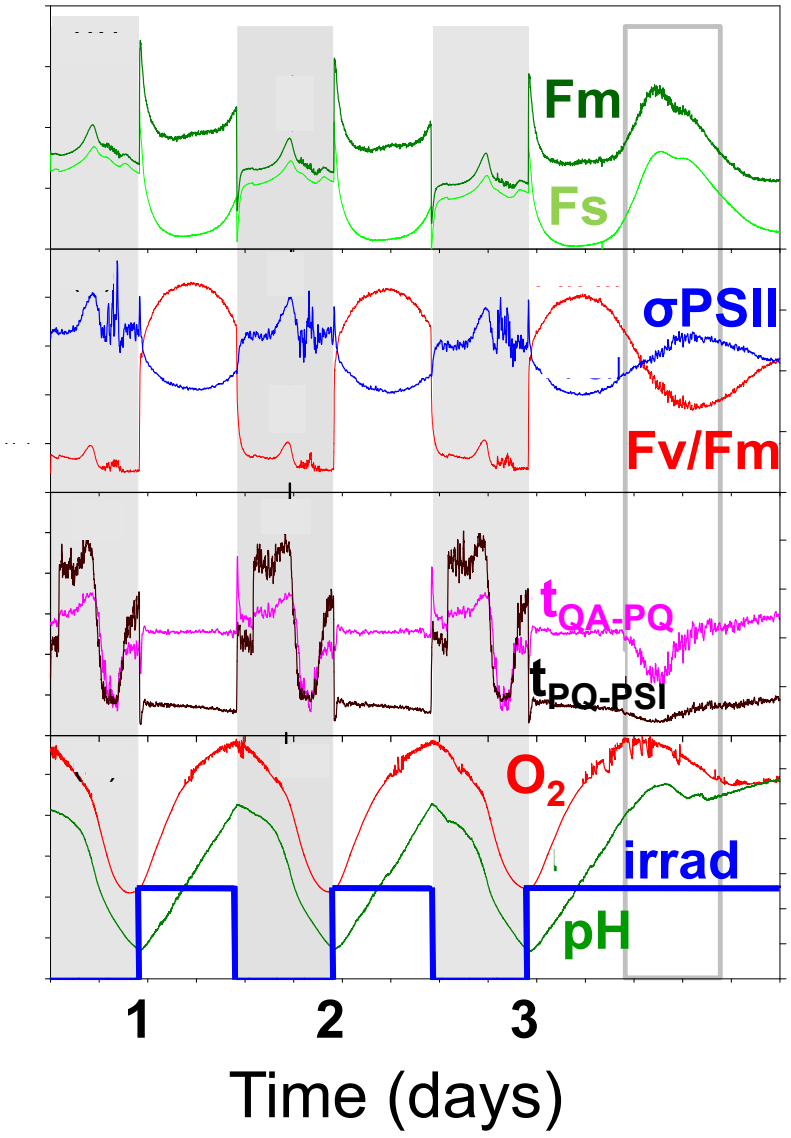
Things like nitrogen transport may not be ‘niche defining’ (you die if you aren’t good at N)

Can genes reveal ‘subtleties’ not currently considered?

(need controlling factors for developing mechanistic carbon cycling models)

Need gene function(s)

*pH*stats for systems biology



Kolber et al.

>*pH*-chemostats
(Kolber, exps. at MBARI)

>Continuous flow
cytometry (?)

>1st round Solid
rest Illumina (directional)

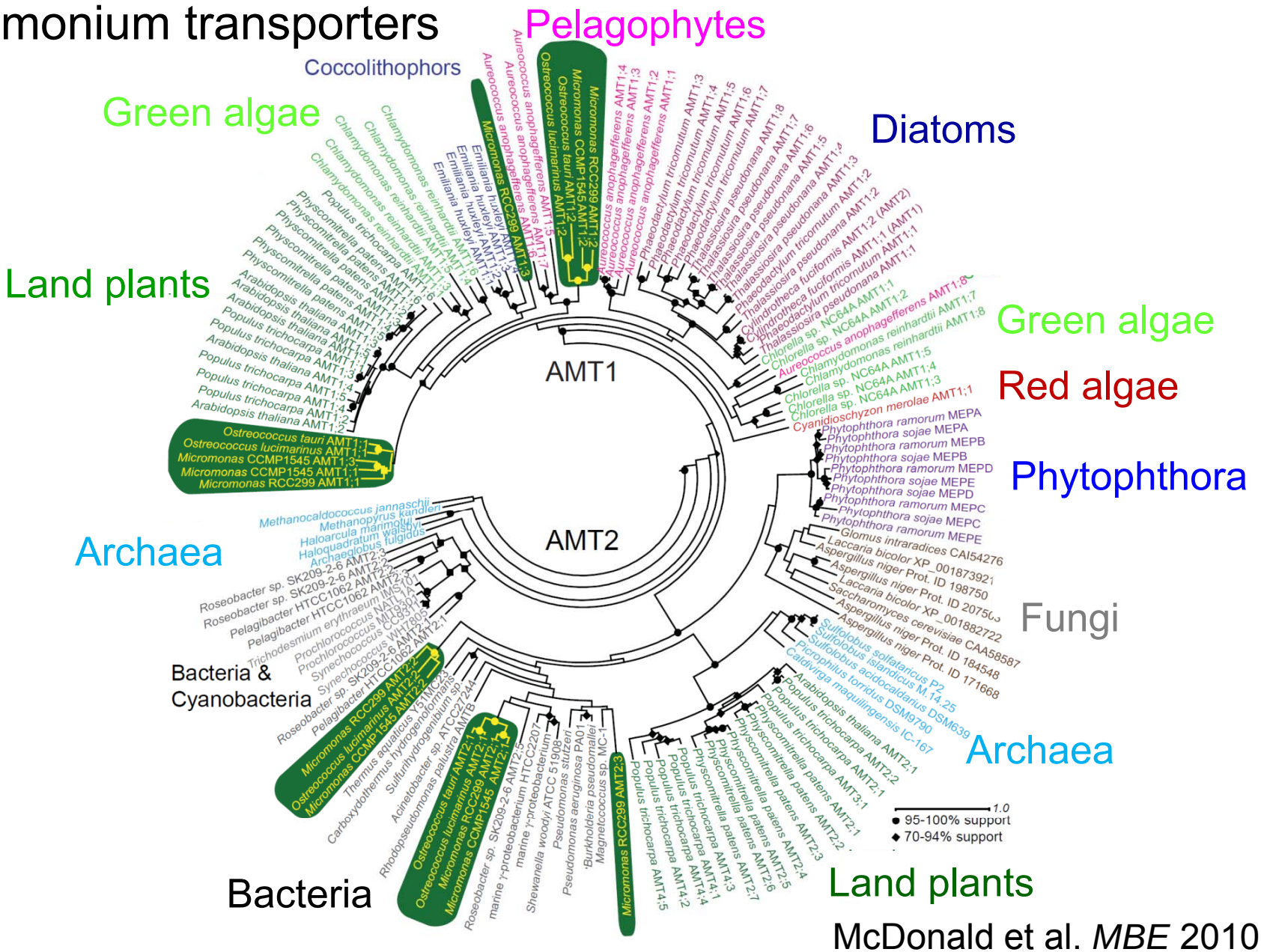
>Blended arrays
(tiling & gene probe)

>Proteomics (PNNL)
(reannotate genome)

>Pathway modeling
(J. Stuart, UCSC)

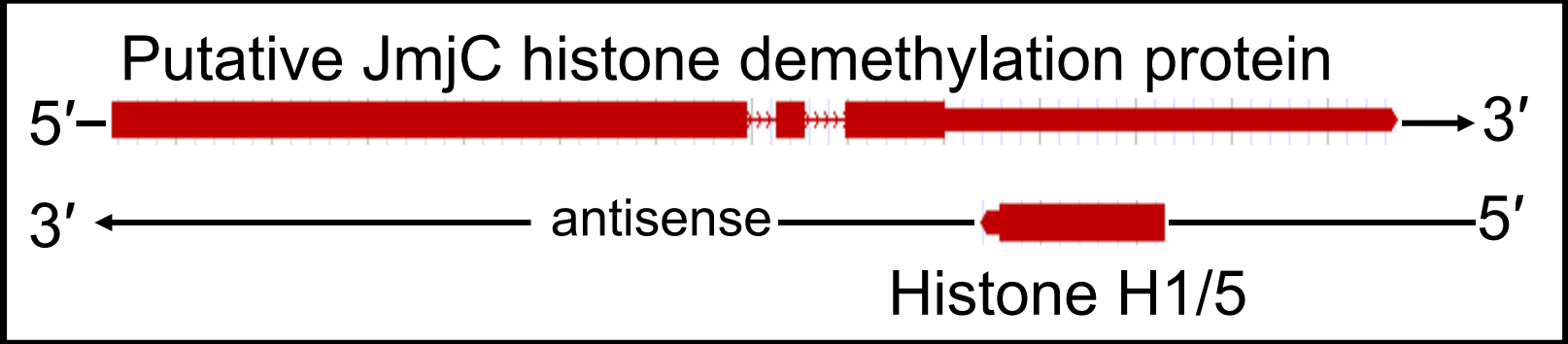
‘Core Mamiellales’ – lineage affiliations

Ammonium transporters



McDonald et al. *MBE* 2010

Can COPs help us investigate function?

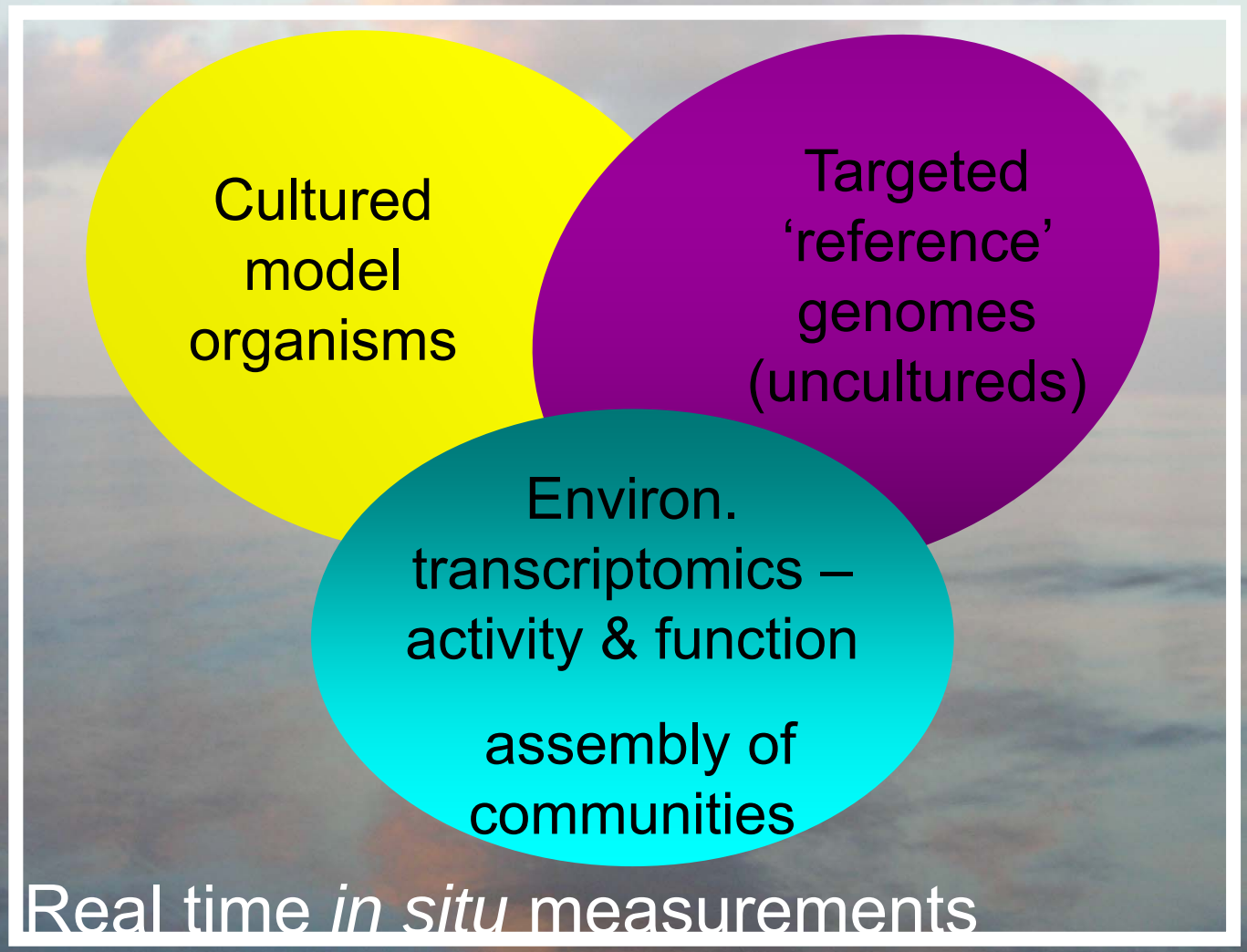


Often one pair member is of unknown function…

% genes forming COPs >> other genomes analyzed to date

4-9% (Human)
1.7-14% (Mouse)
7% (Arabidopsis)
22% (Fruit fly)

Project goals



Biogeochemical processes

Meeting goals

'It is not the powers that you have,
but the way you choose to use them...'

- Albus Dumbledore

Thank you!