Extreme diversity and abundance of planktonic diplonemids in the world oceans

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BIODIVERSITY
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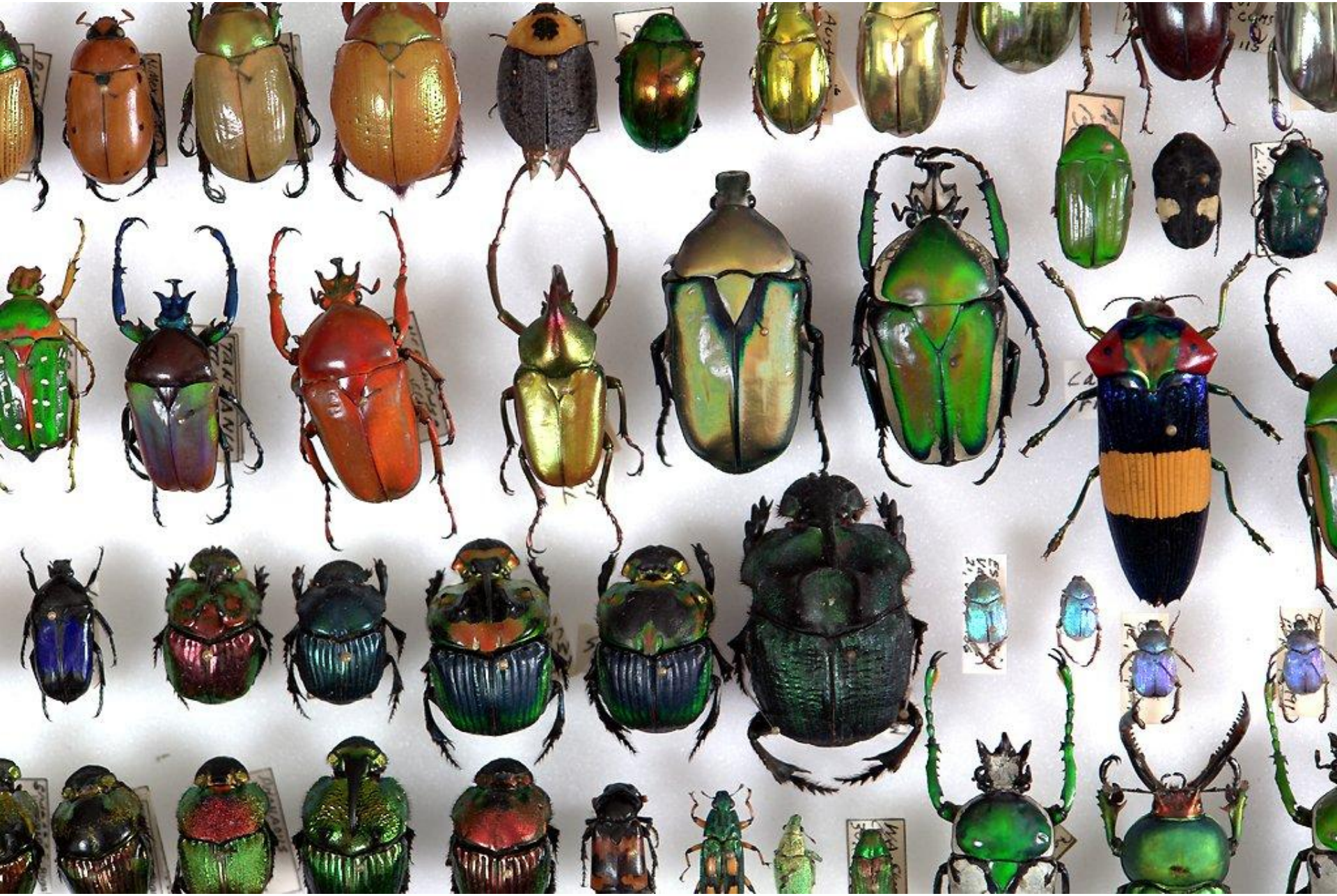
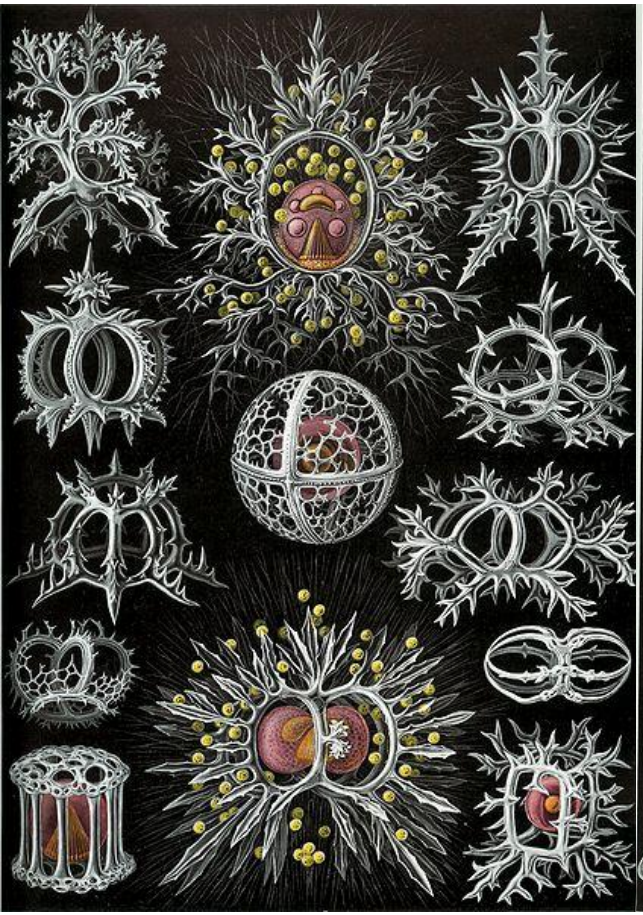
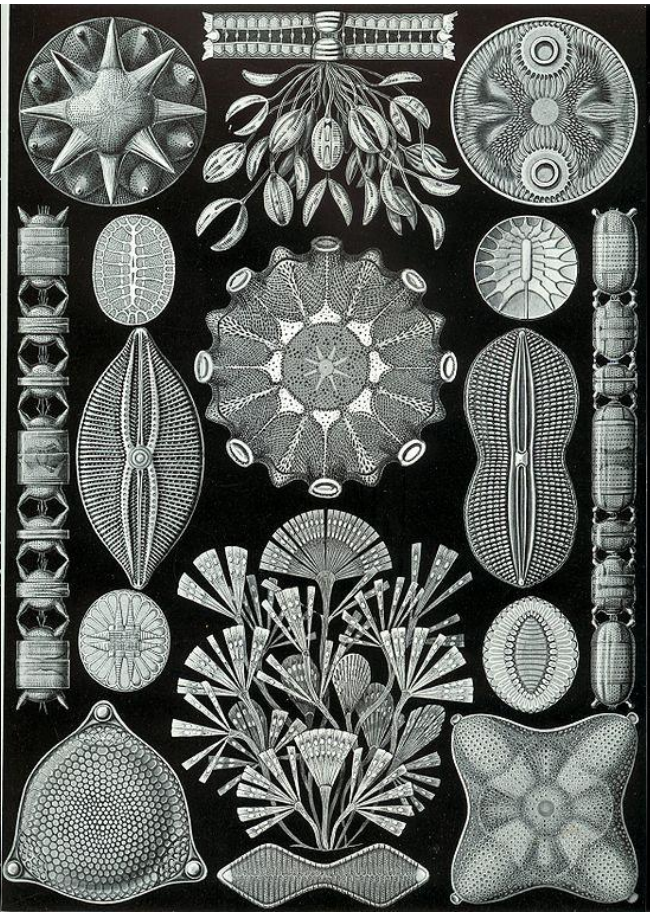


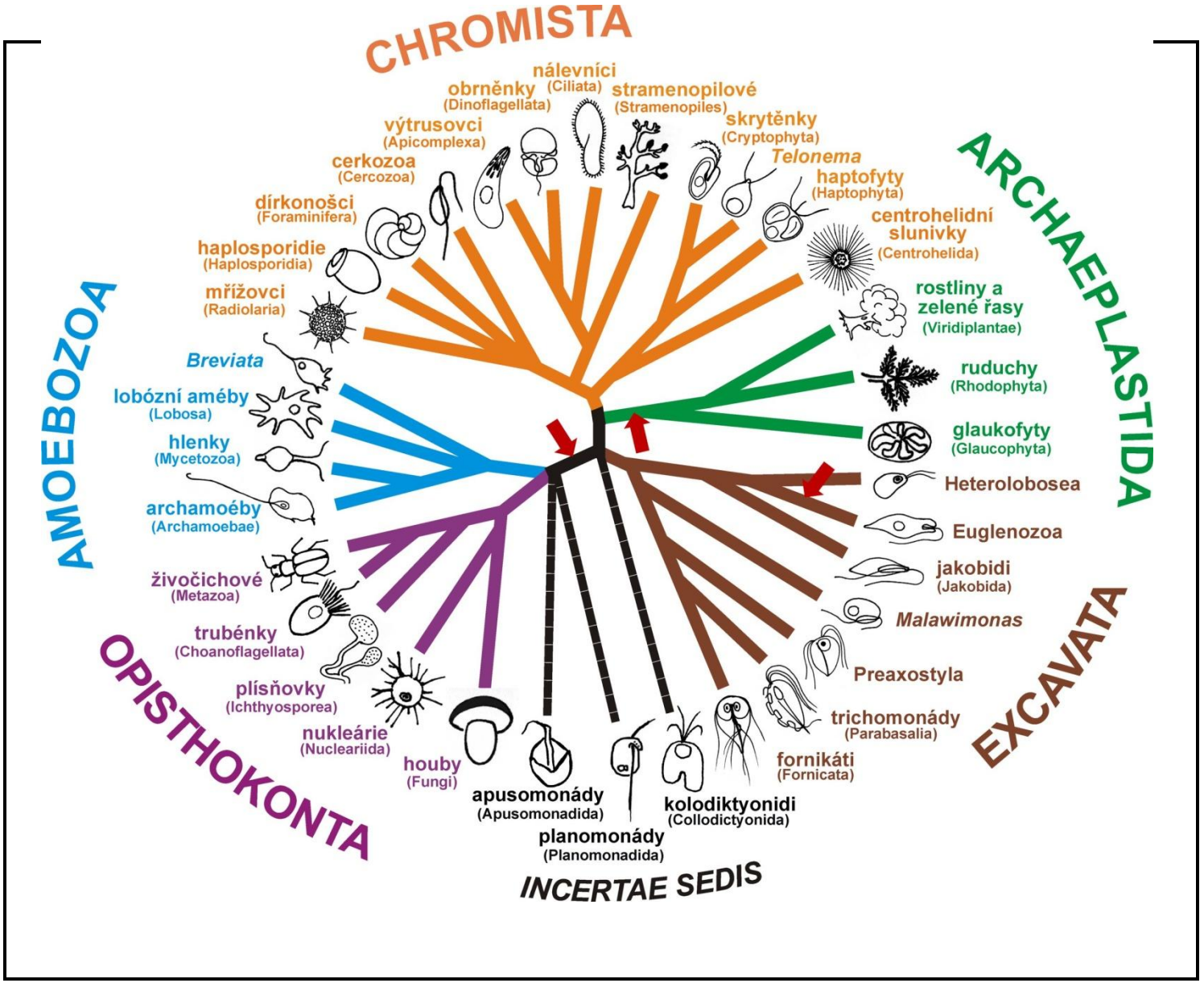
www.insectnet.com





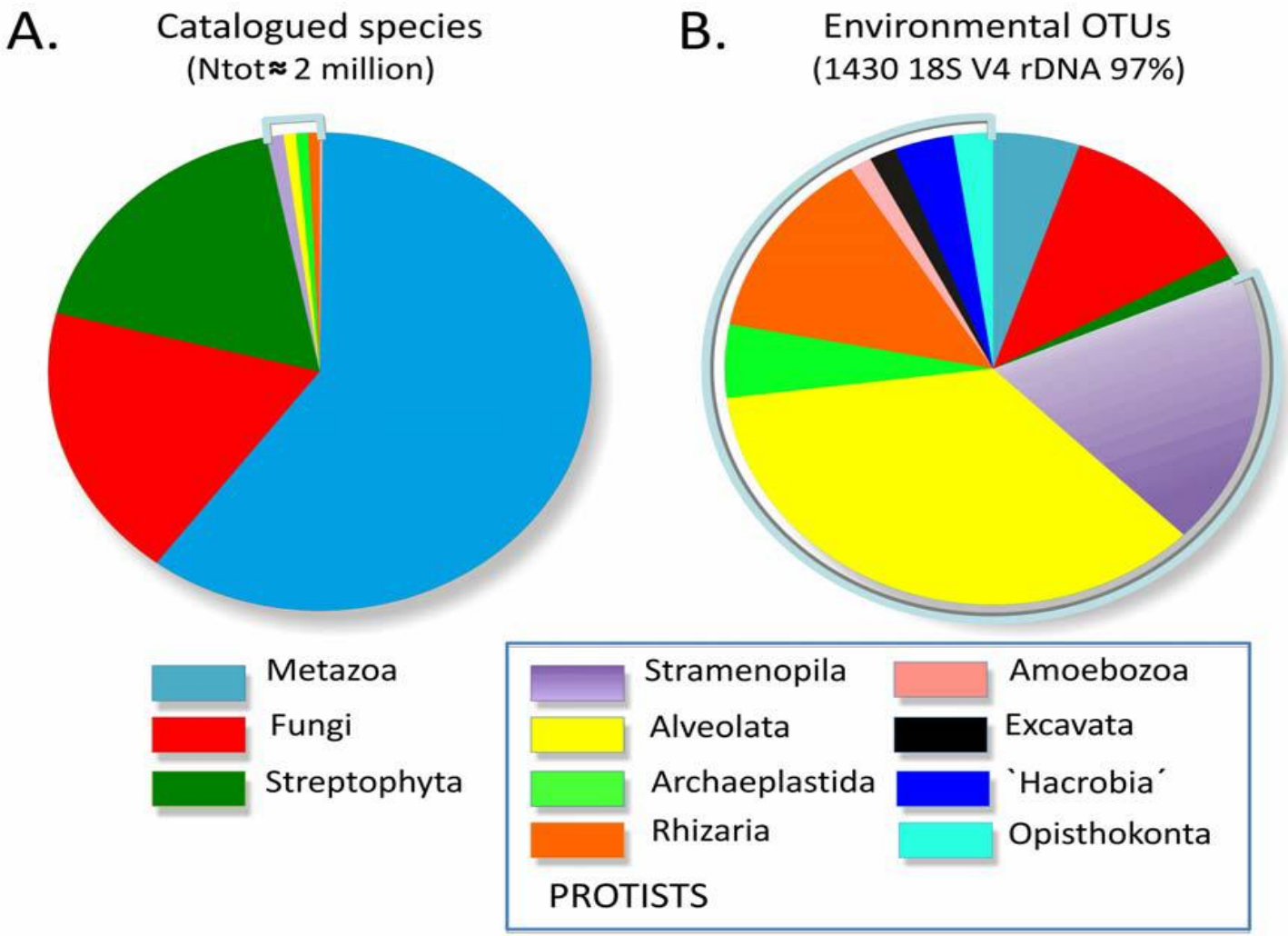
Biodiversity of world ocean?

Current view of eukaryotic diversity



Adl et al., JEM 2012

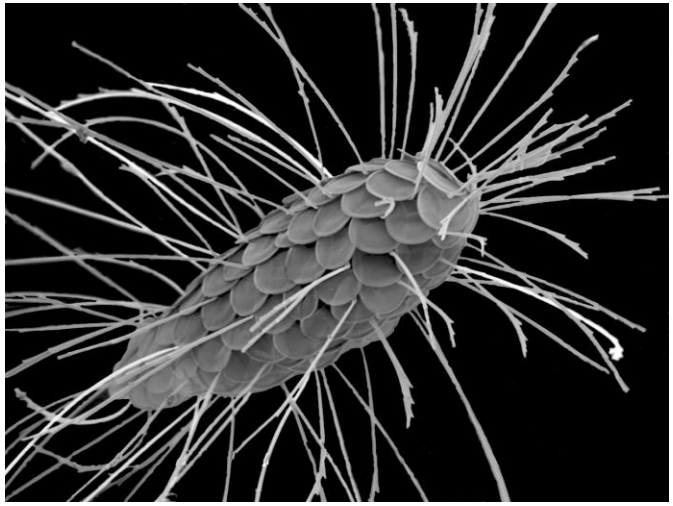
Enormous diversity in number of species

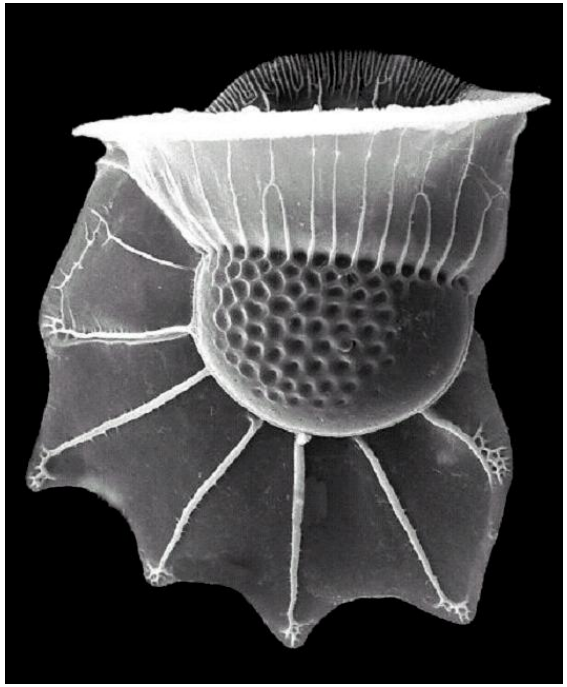


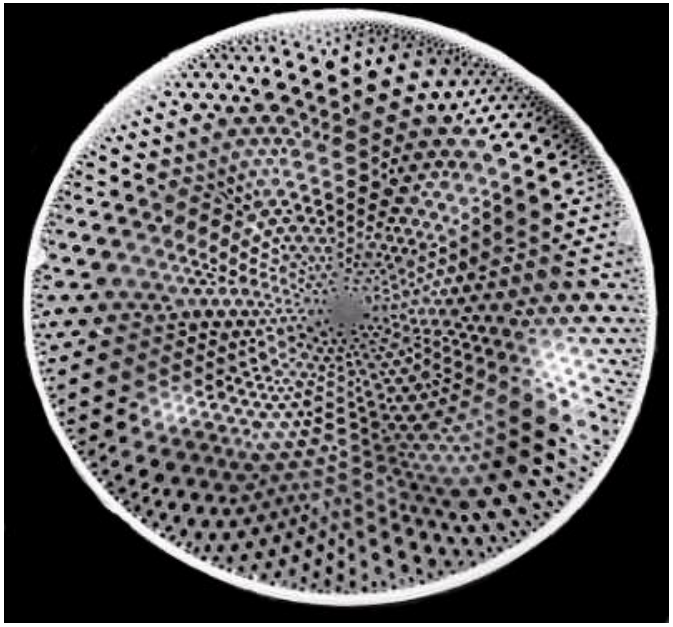
Morphological versus genetic views of total eukaryotic diversity. (A) Relative numbers of described species per eukaryotic supergroup. (B) Relative number of V4 18S rDNA Operational Taxonomic Units (97%) per eukaryotic supergroup, based on 59 rDNA clone library surveys of marine, fresh-water, and terrestrial total eukaryotic biodiversity.

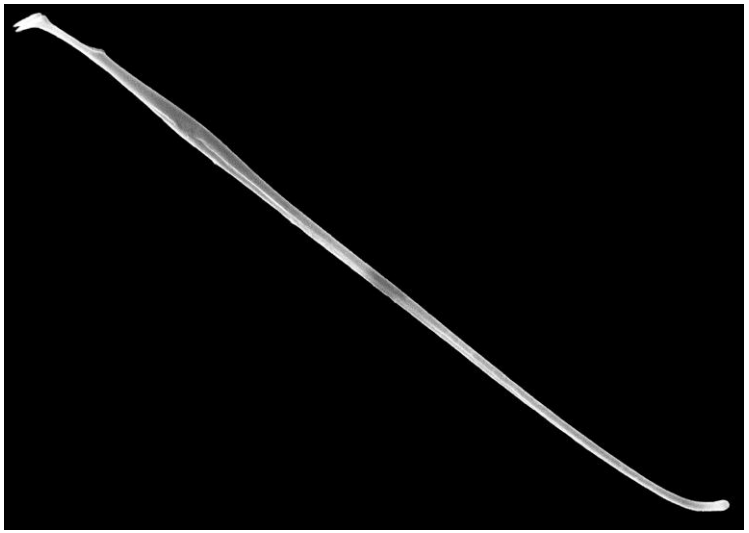
Pawlowski et al., PLoS Biology 2012

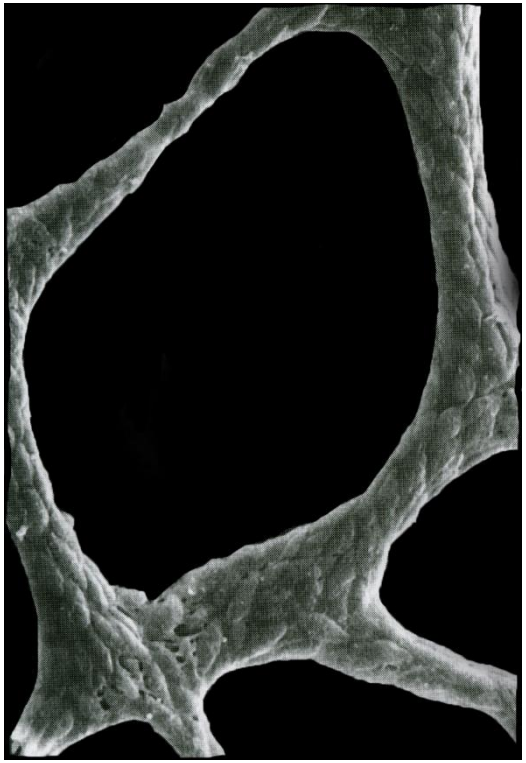
Enormous diversity of protists in morphology

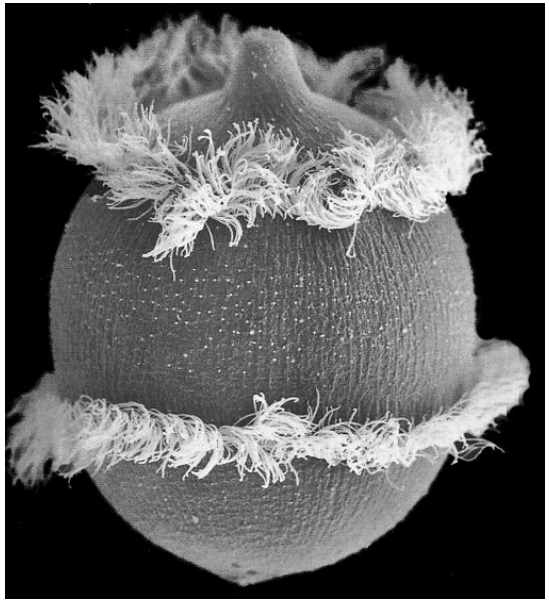


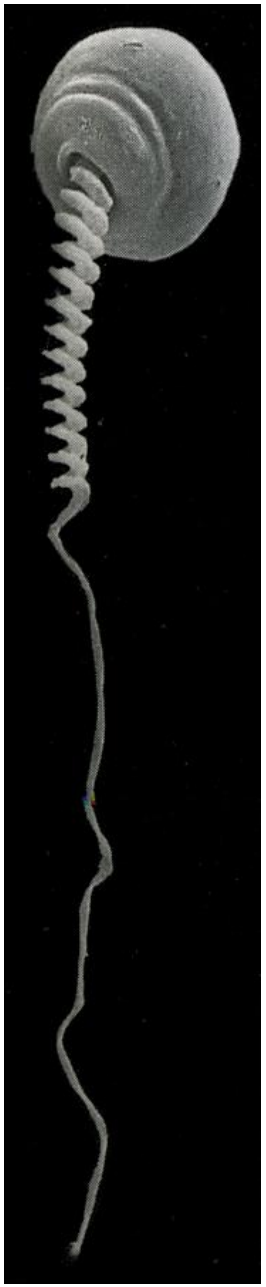


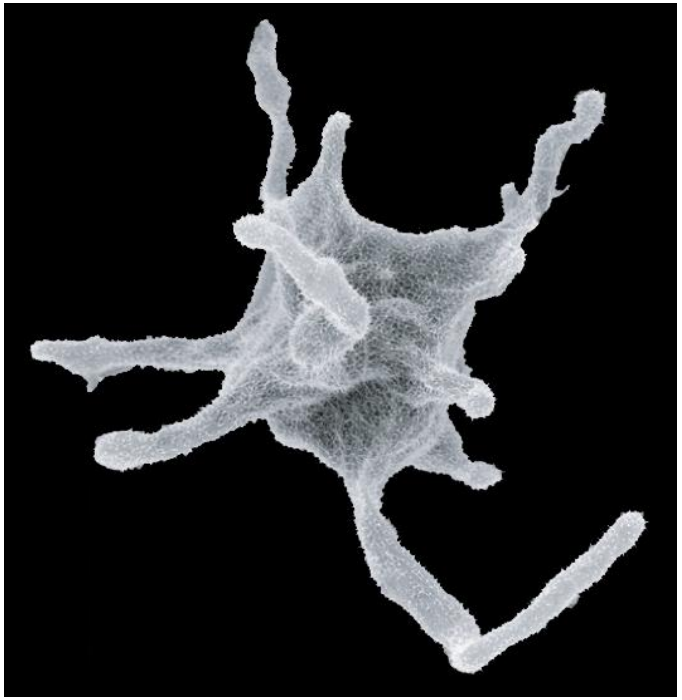


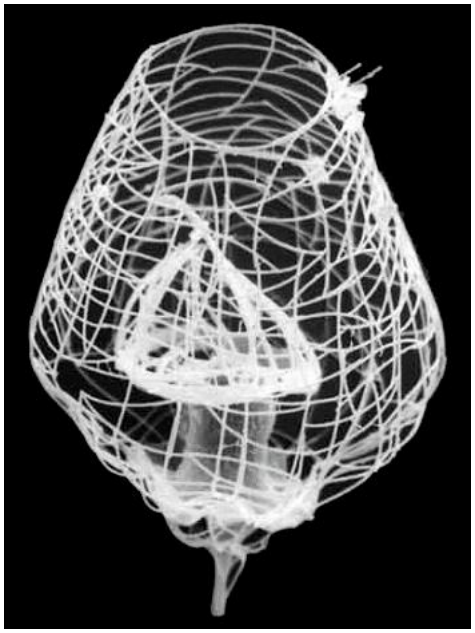


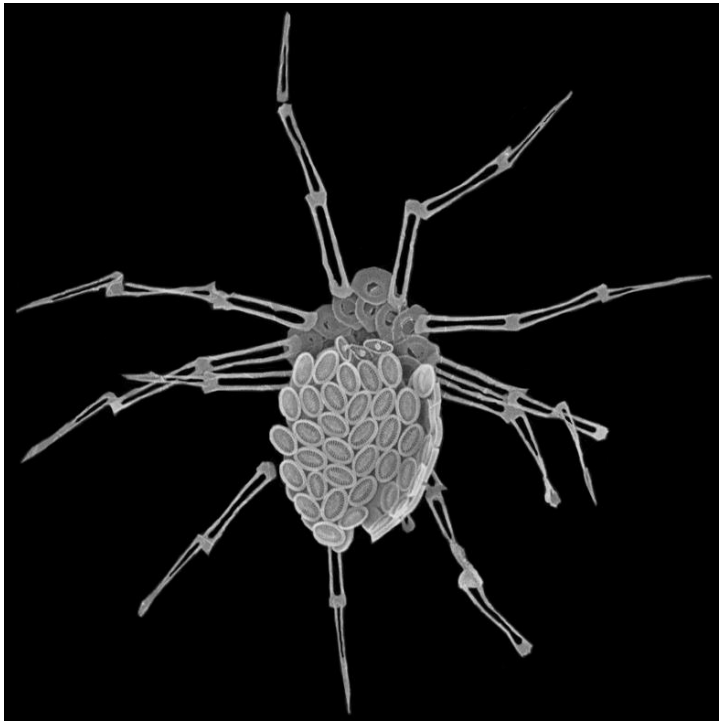


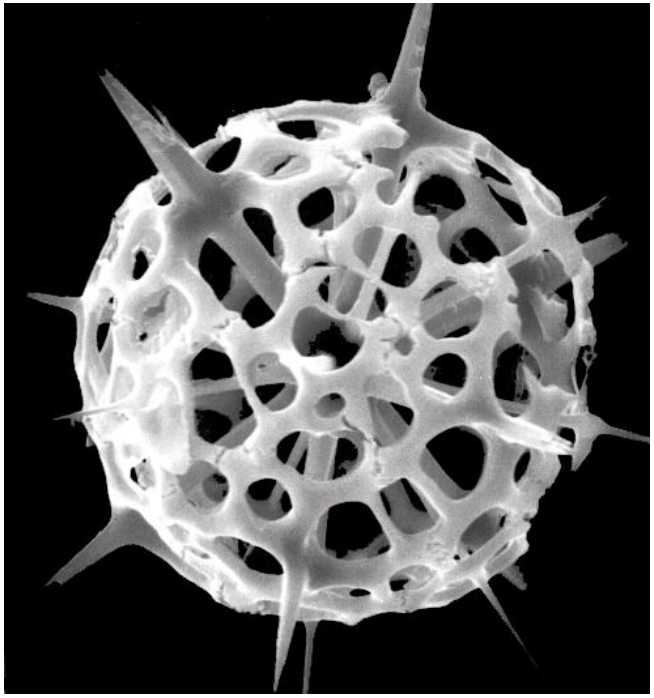


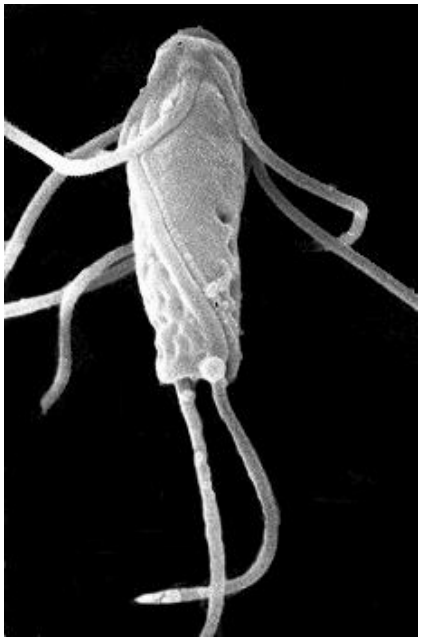


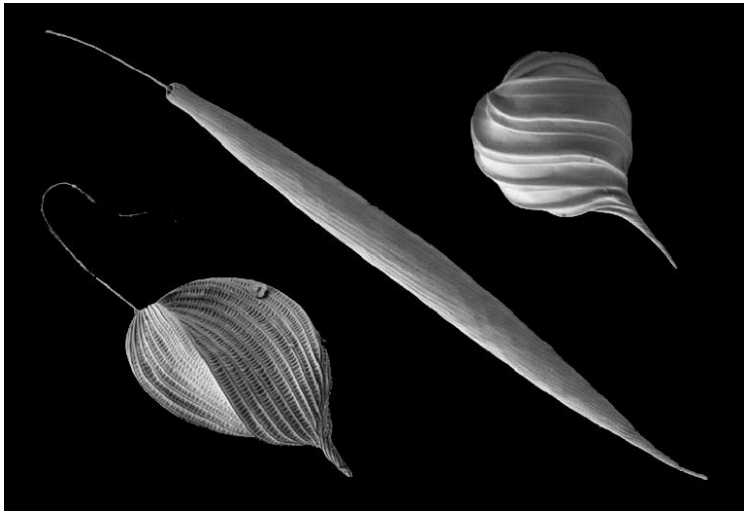




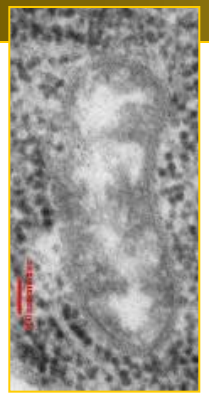




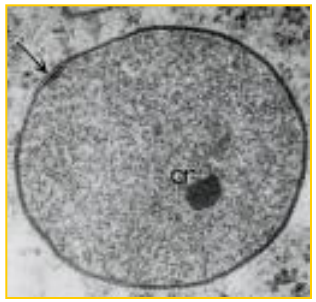


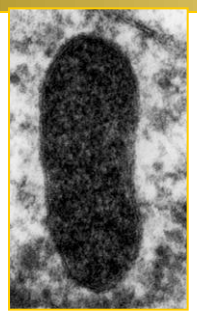


Unexpeted diversity of mitochondrion-derived organelles



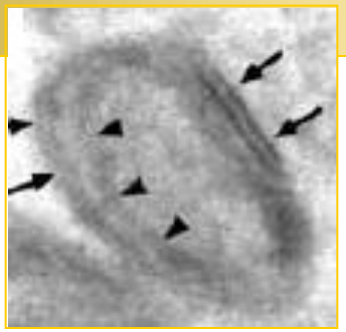
Trimastix



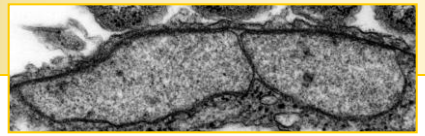


Parabasala

Retortamonadida



Diplomonadida

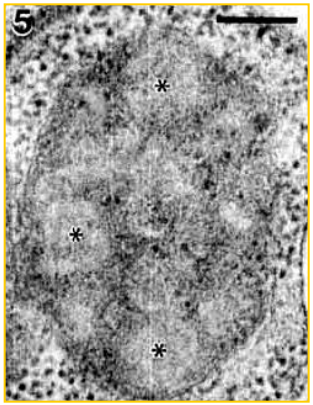


Euglenozoa

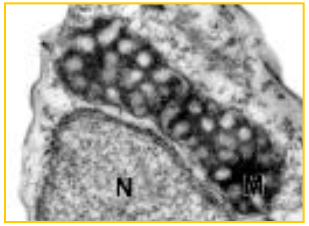
Heterolobosea

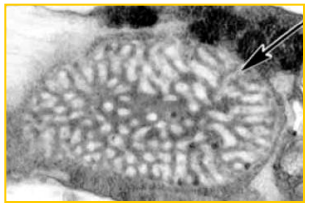
?

Oxymonada



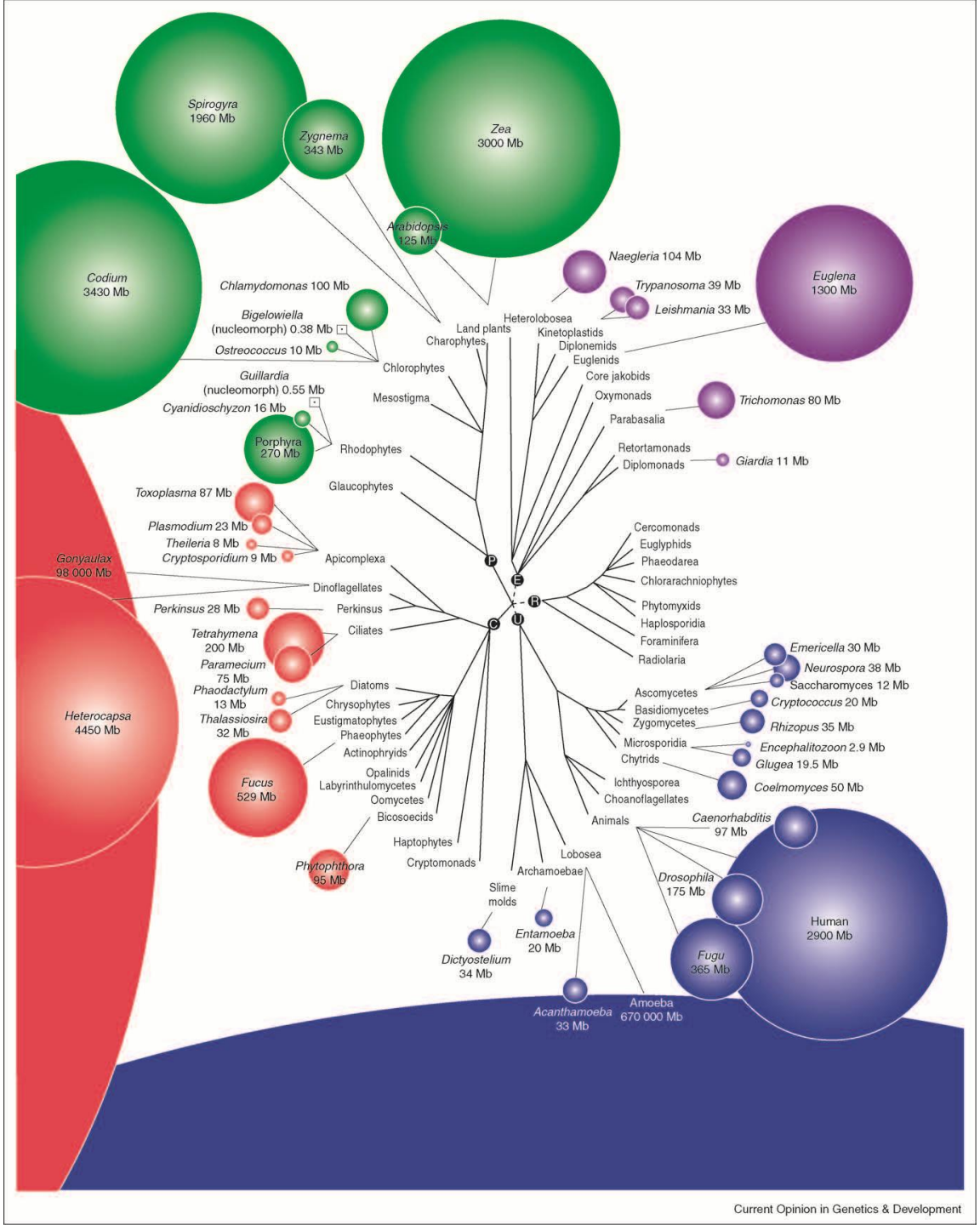
Carpediemonas





Jakobids

Malawimonas



Current Opinion in Genetics & Development

Enormous diversity of genome size in protists

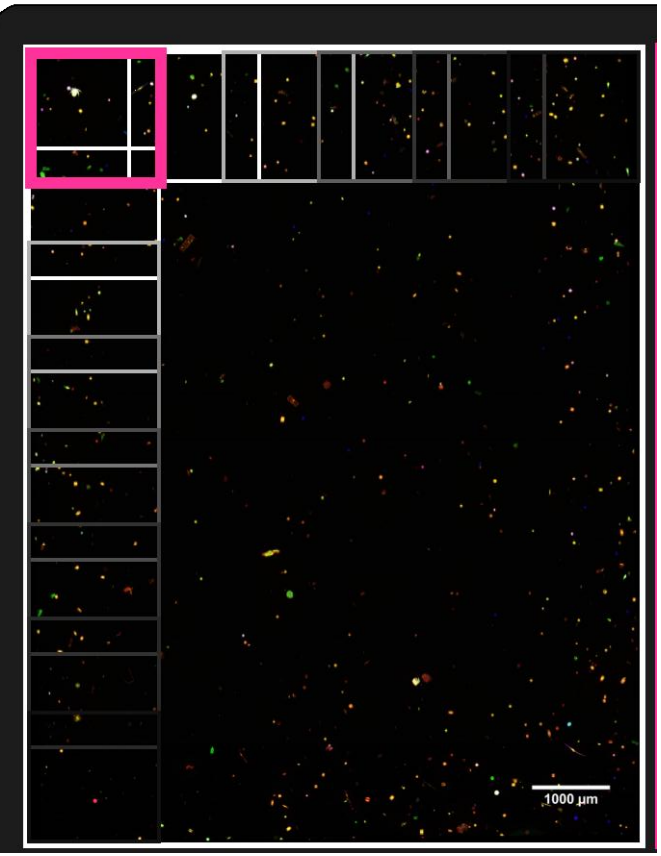
Eric Karsenti & Etienne Bourgeois

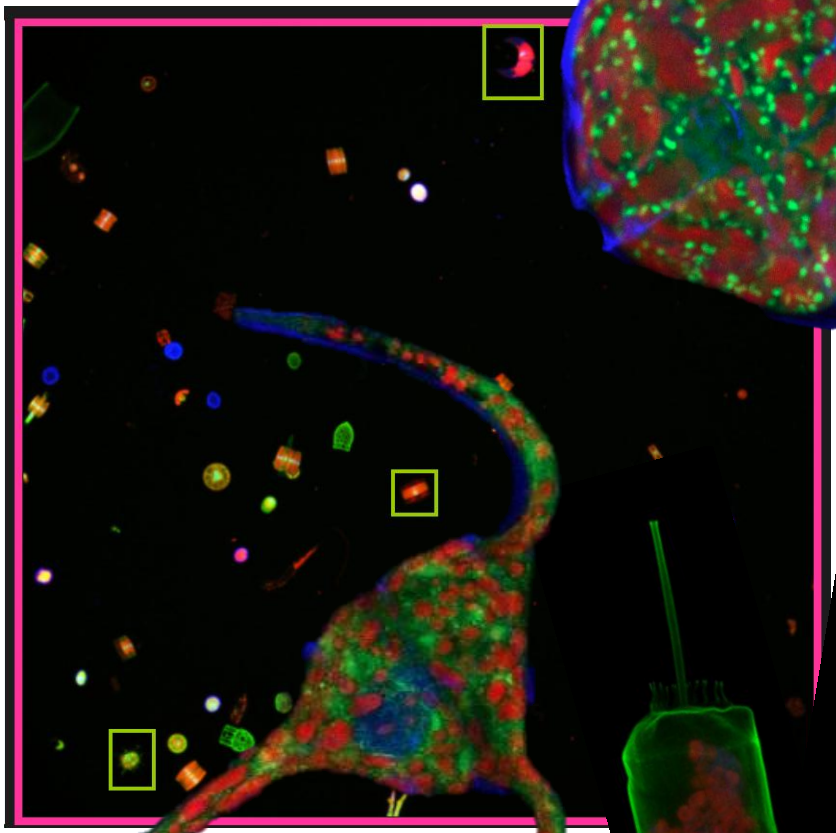
TARA OCEANS

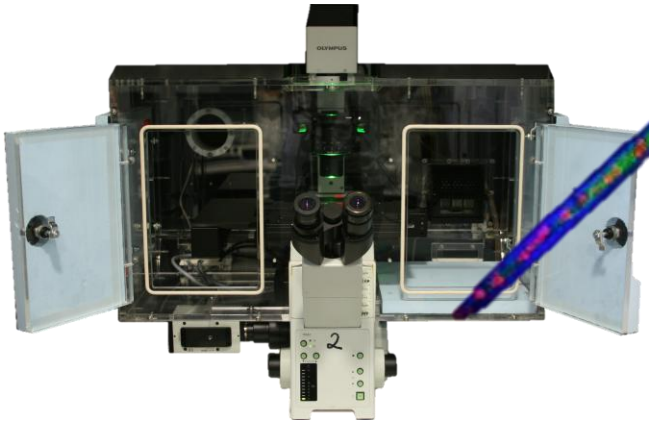
2009 - 2012

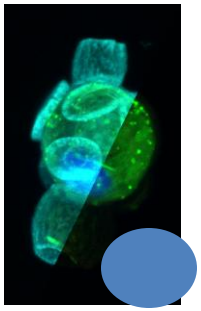

SEPT 2009
SEPT 2012
MARS 2010
SEPT 2010
OCEAN
ATLANTIQUE
NORD
TARA
OCEANS
supervind

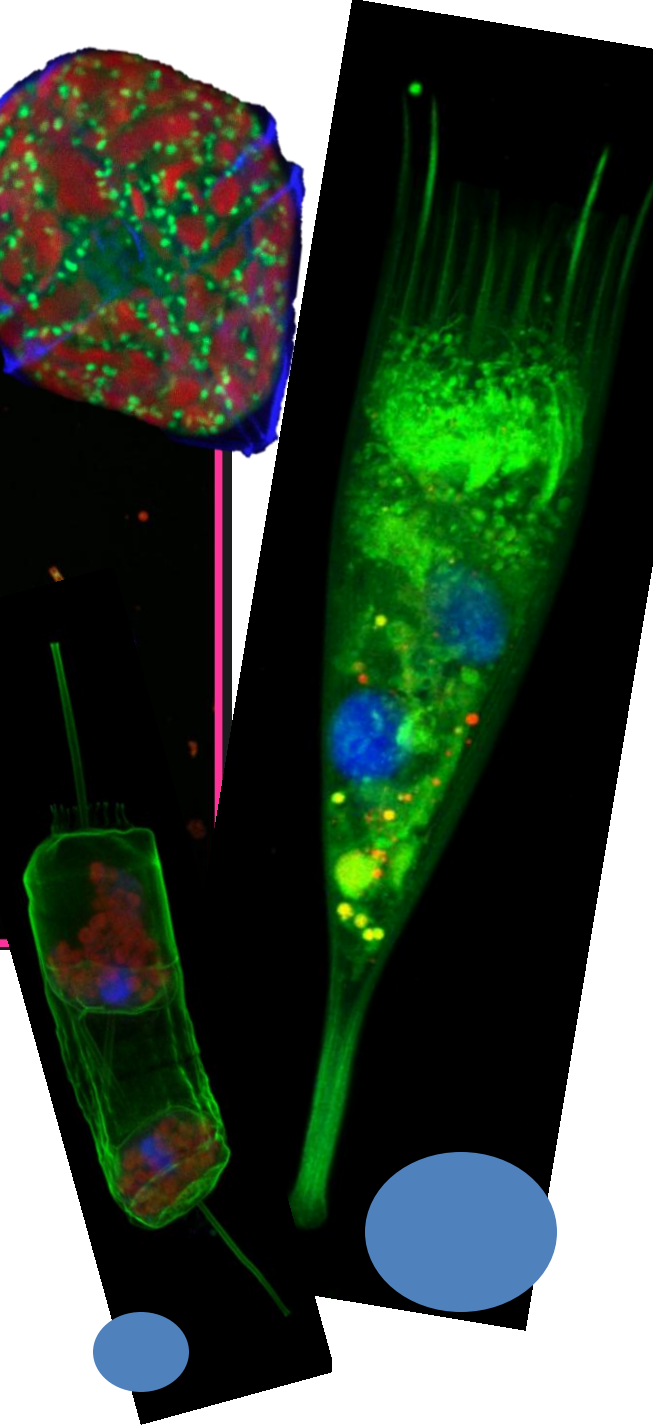

PLASTIMO
KIMTECH


1000 µm



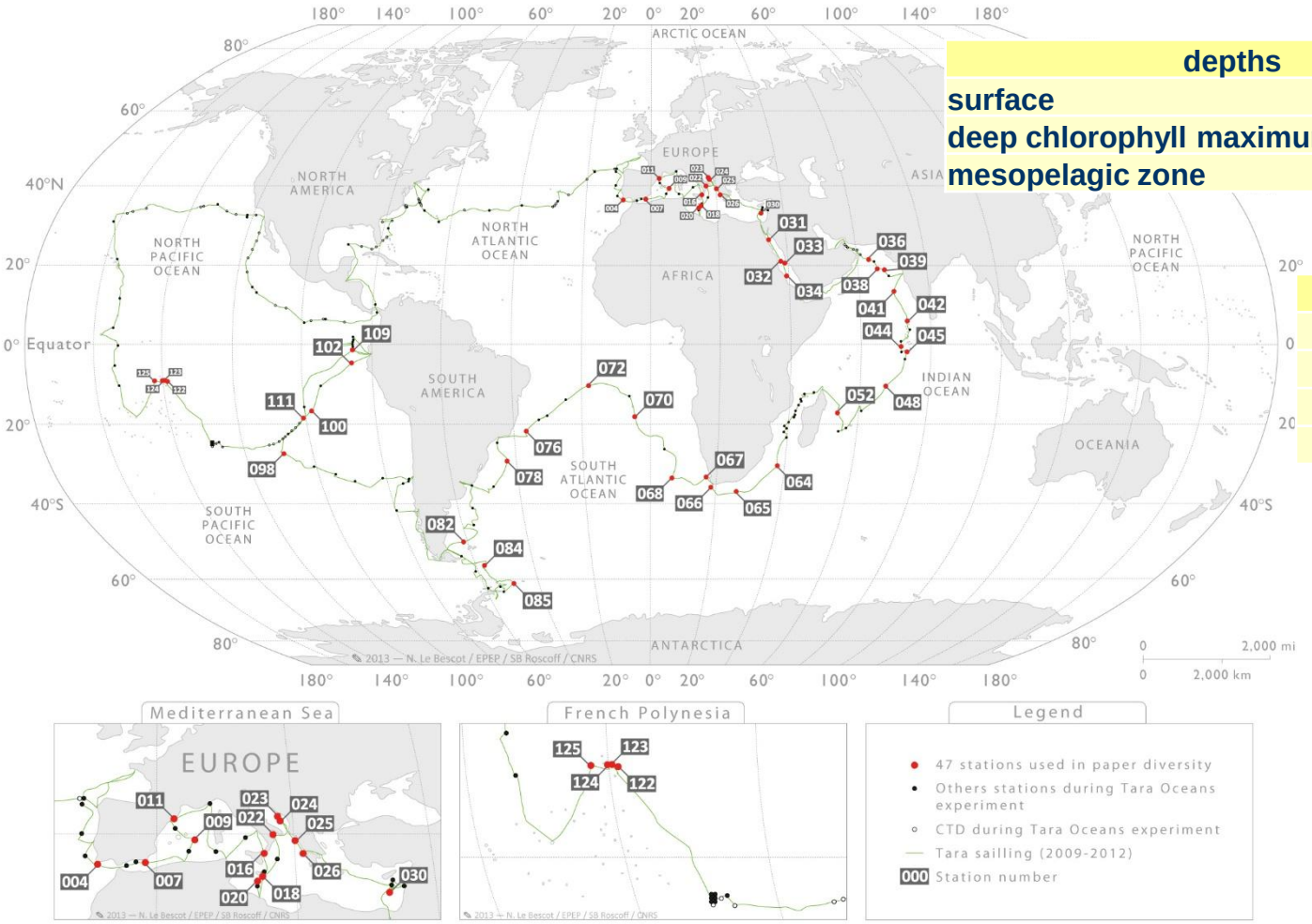






Tara Oceans Expedition, 2009-2012

381 samples from 49 locations

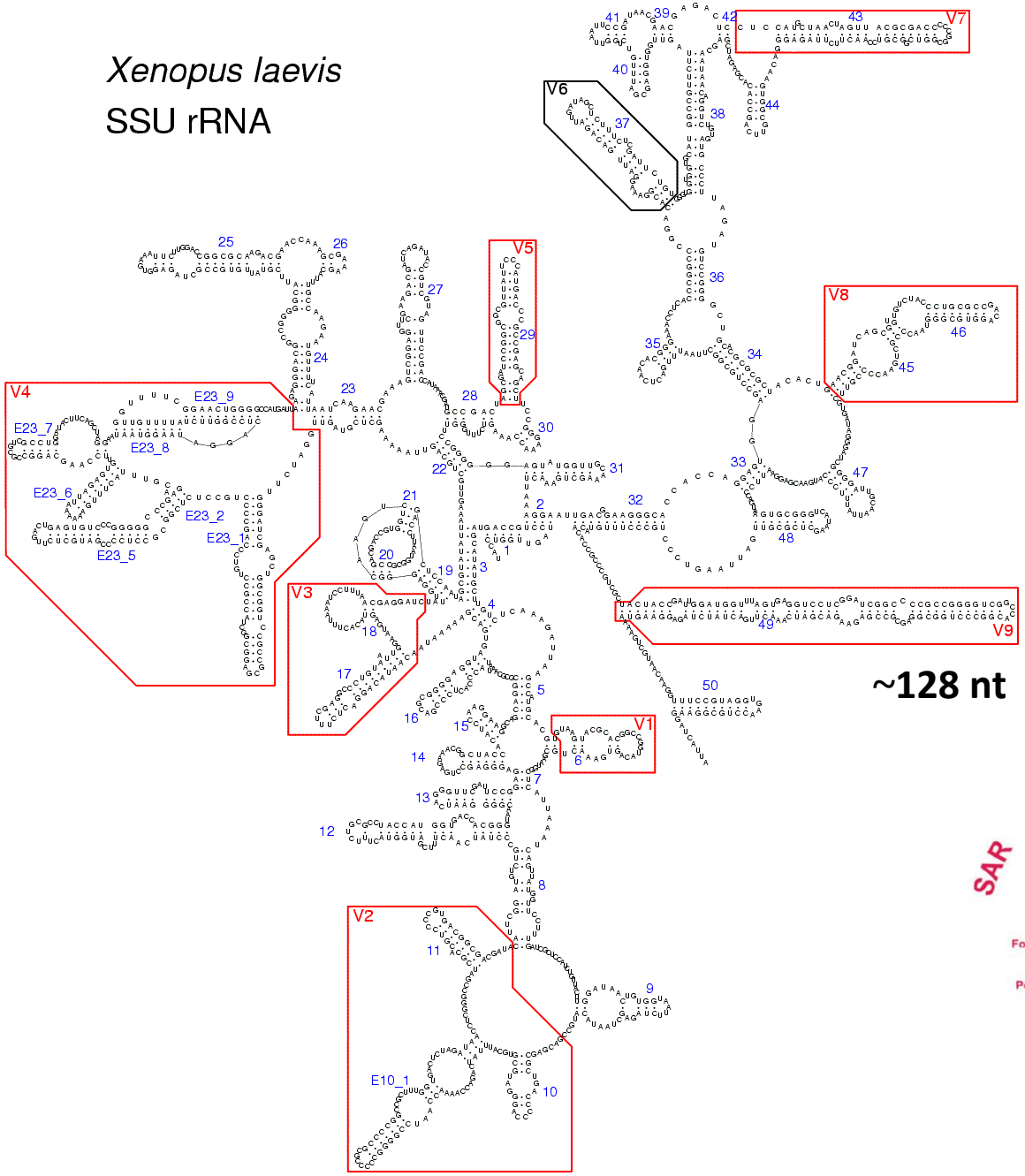


depths	
surface	5-10 m
deep chlorophyll maximum	17-184 m
mesopelagic zone	268-852 m

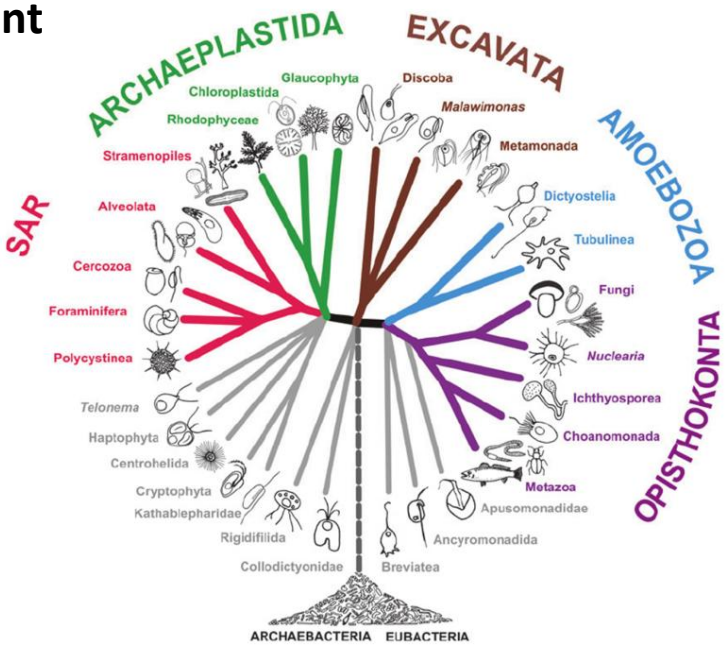
size fractions
0.8-5 µm
5-20 µm
20-180 µm
180-2000 µm

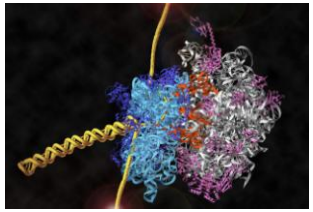
Xenopus laevis

SSU rRNA

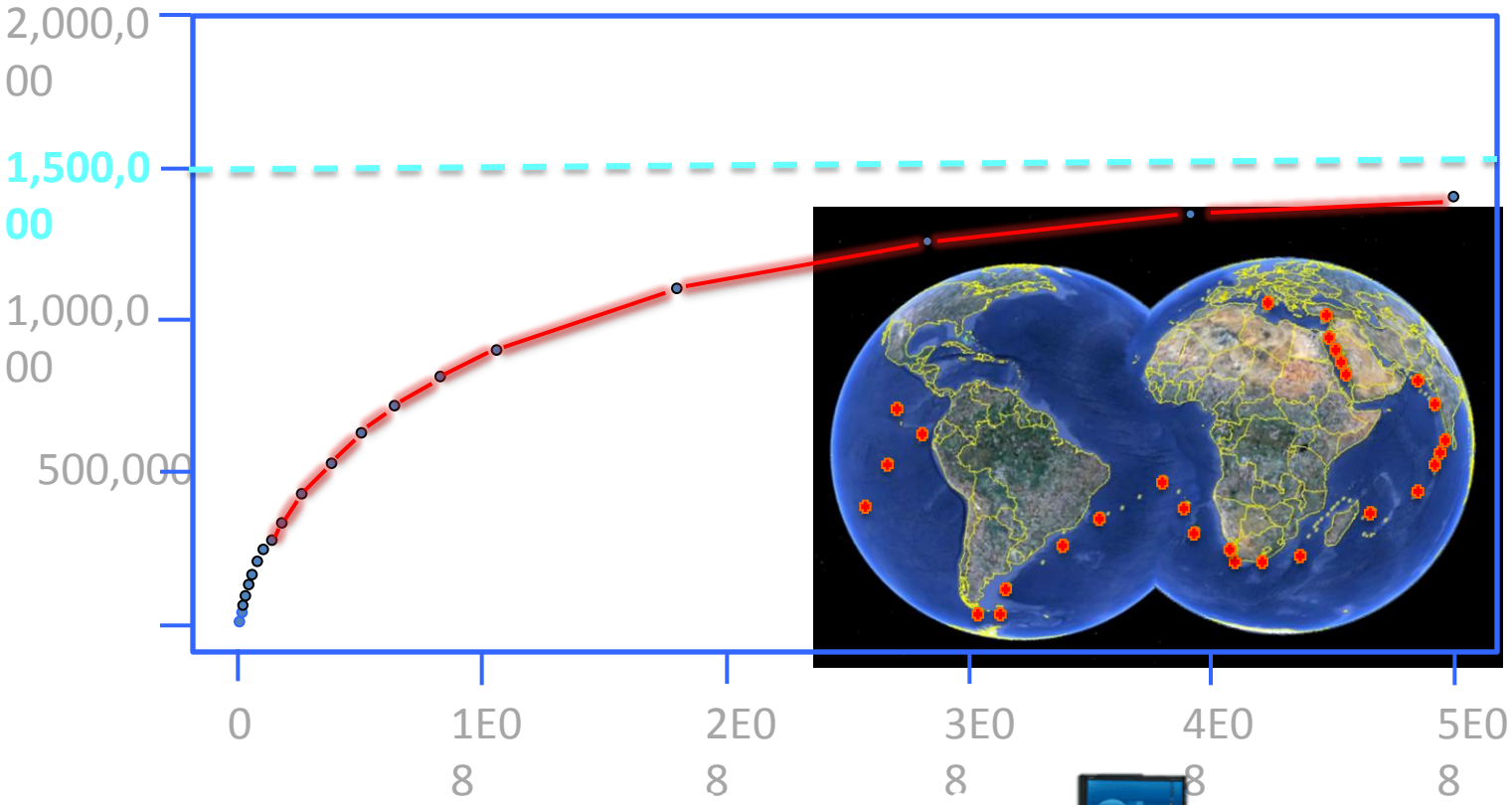


~128 nt

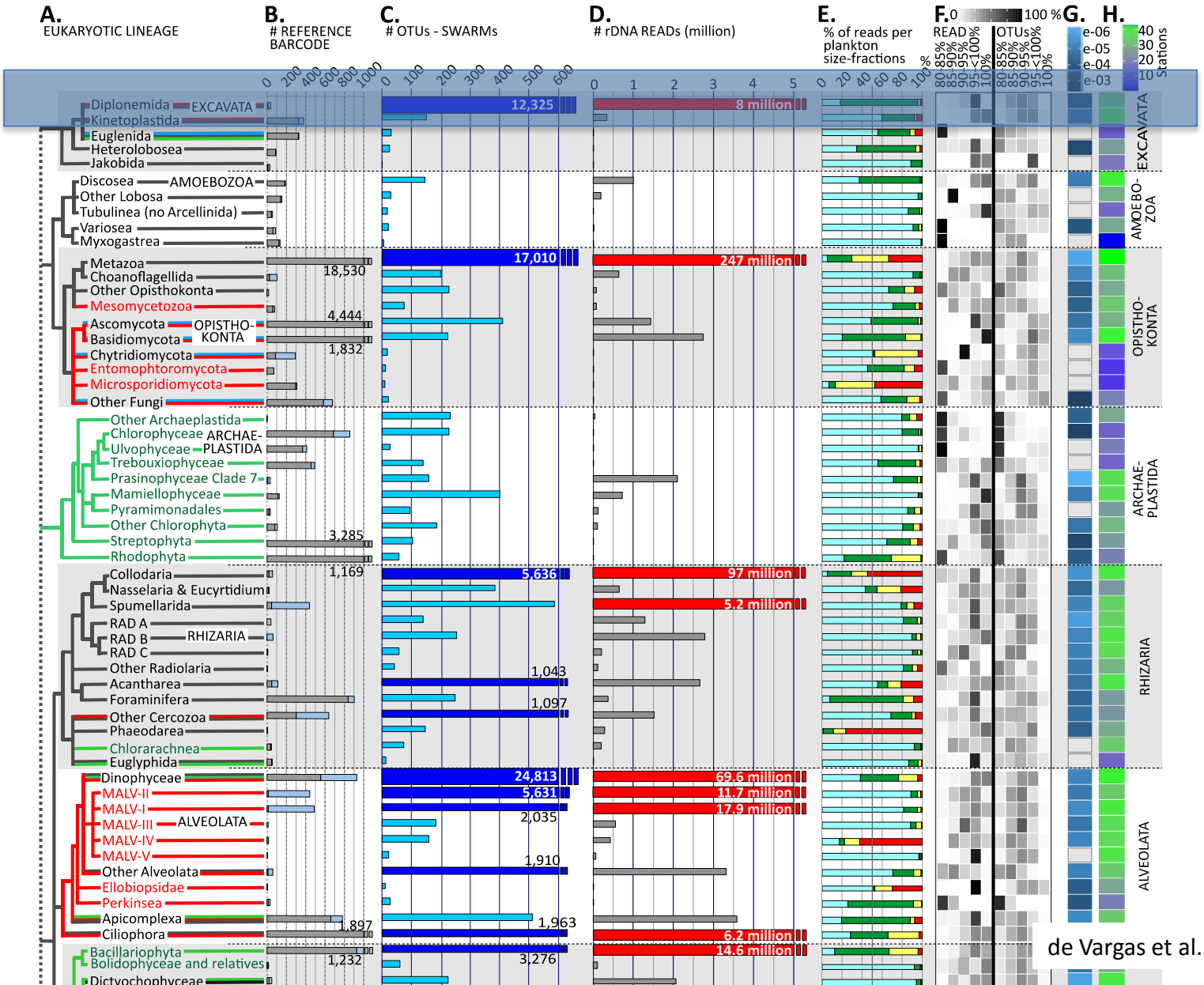




~1,5 million protist + animal taxa in photic oceanic plankton



THE GLOBAL ANALYSIS OF THE V9 DIVERSITY OF THE PHOTIC LAYER

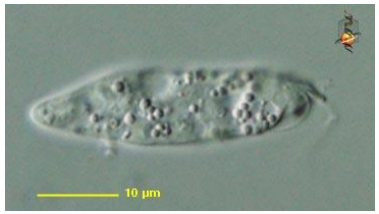


de Vargas et al. Science 2015

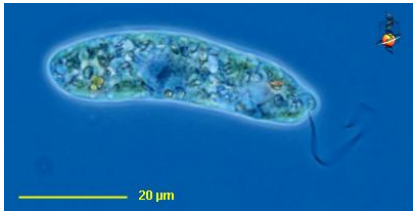
DIPLONEMIDS?!

The **Euglenozoa** clade is a primitive eukaryotic group of flagellates.

Trypanoplasma borreli



Diplonema papillatum



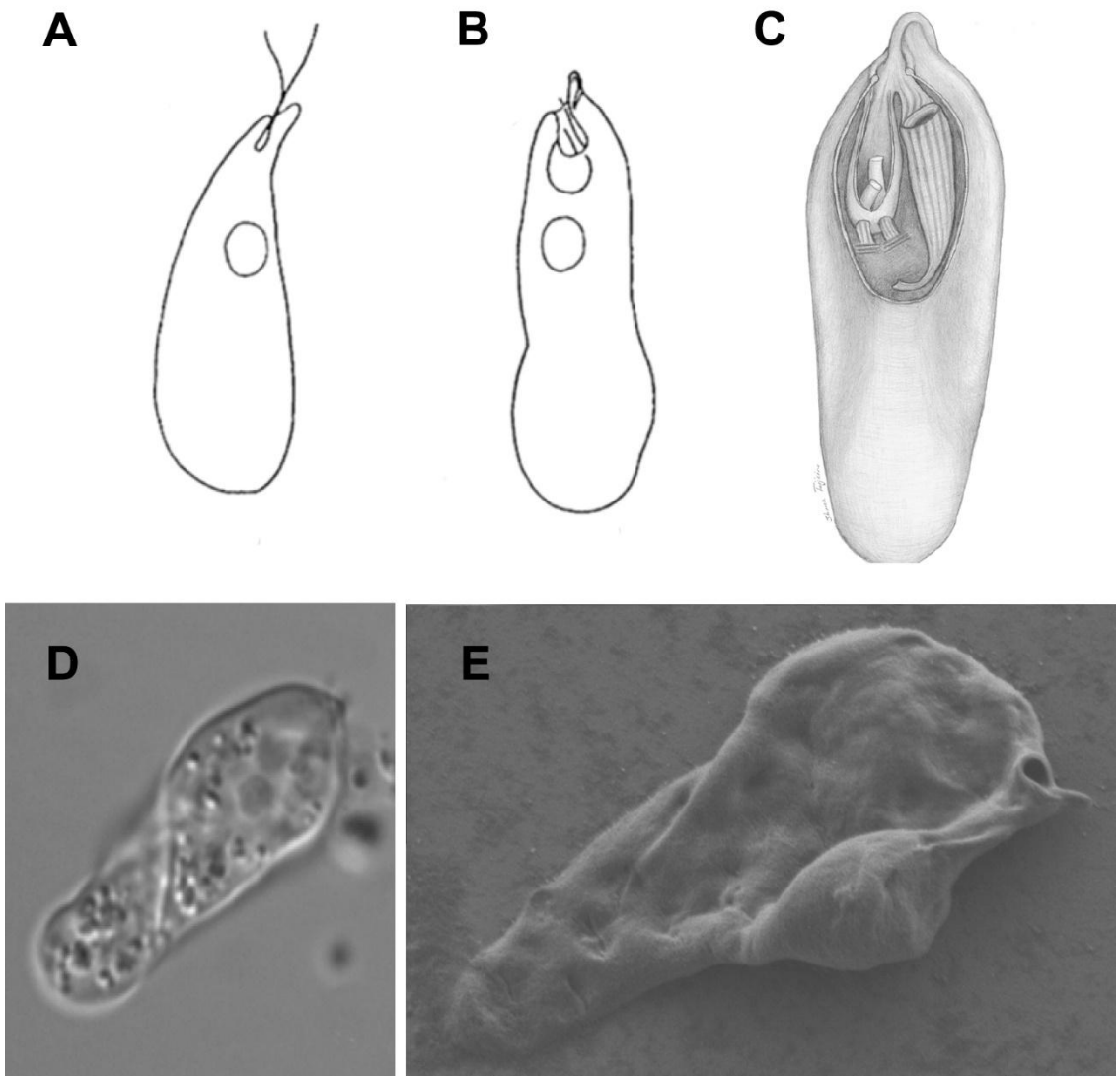
Euglena acus

Kinetoplastids

Diplonemids

Euglenids

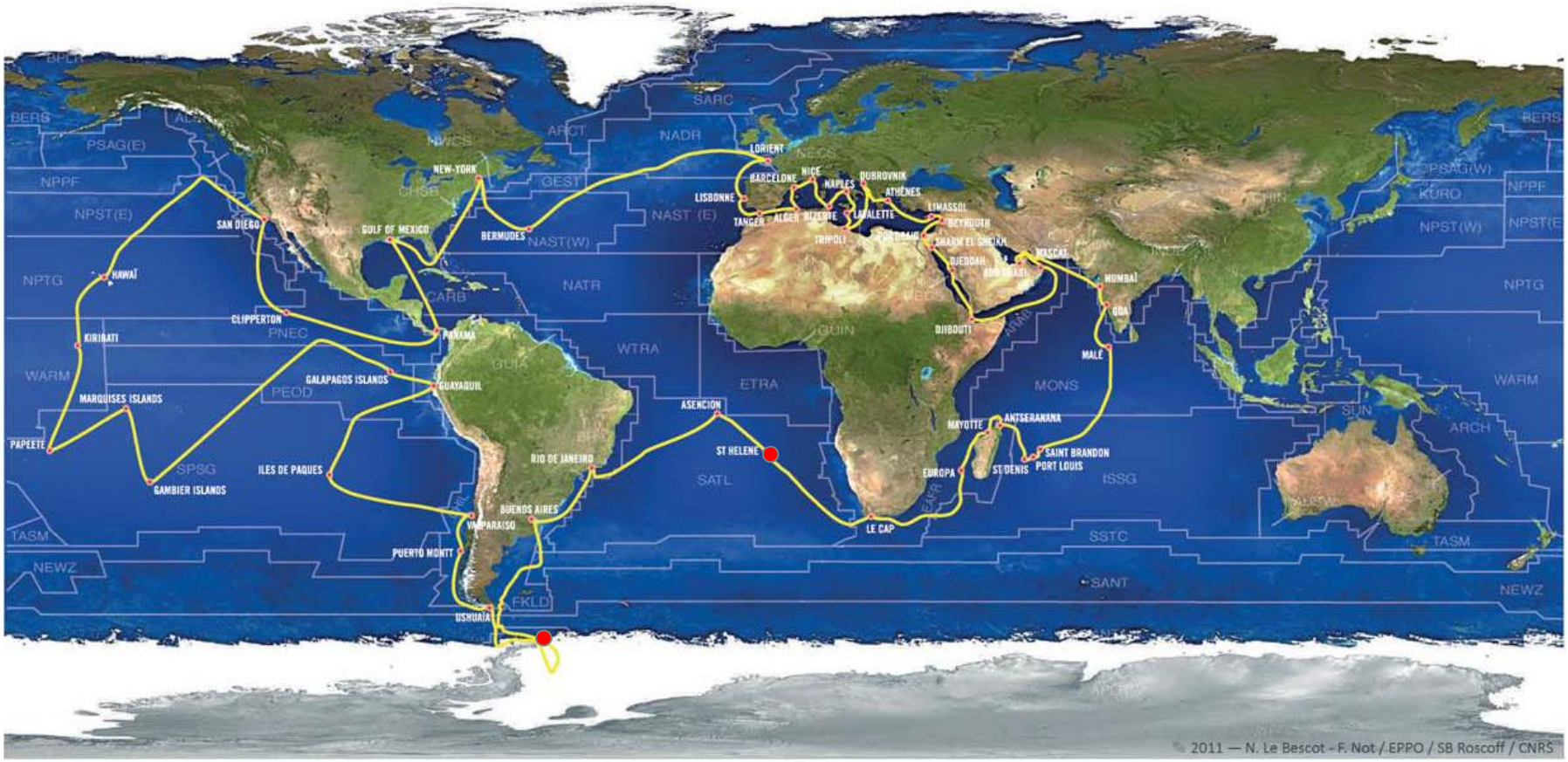
Summary of our knowledge of diplonemid morphology



A *Diplonema breviciliata* (Simpson 1997);

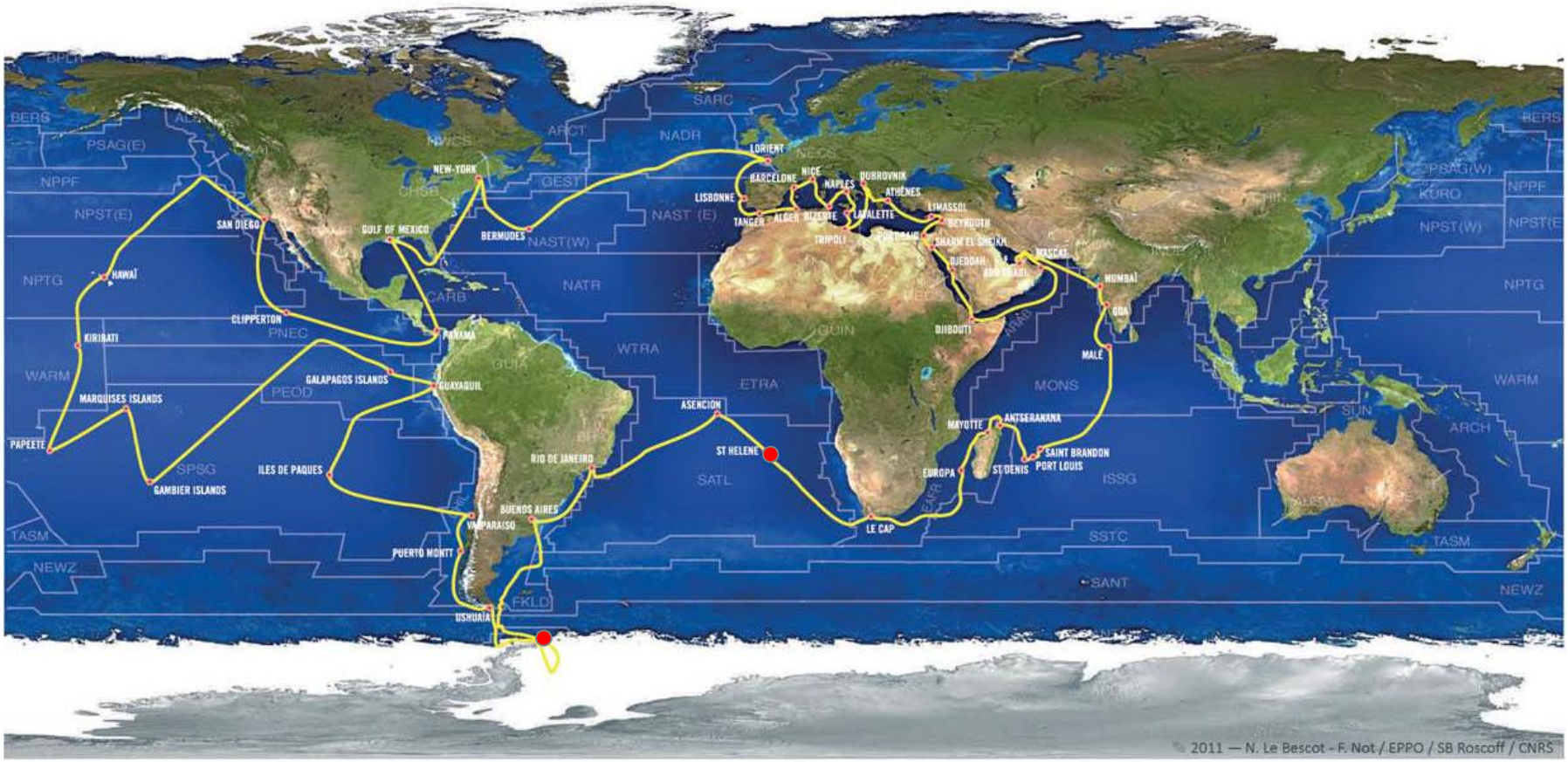
B *Rhynchopus* sp. (Simpson 1997);

C-E *Rhynchopus euleeides* (Roy et al. 2007)



total abundance: 1,315,922 barcodes
clade: novel diplonemid
sample: 71% of total barcodes in the sample
size fraction: 3 µm - infinity
depth: 784 m
temperature: 0.5 C

total abundance: 845,473 barcodes
clade: planktonic diplonemid
sample: 51% of total barcodes in the sample
size fraction: 0.8-3 µm
depth: 791 m
temperature: 4.2 C



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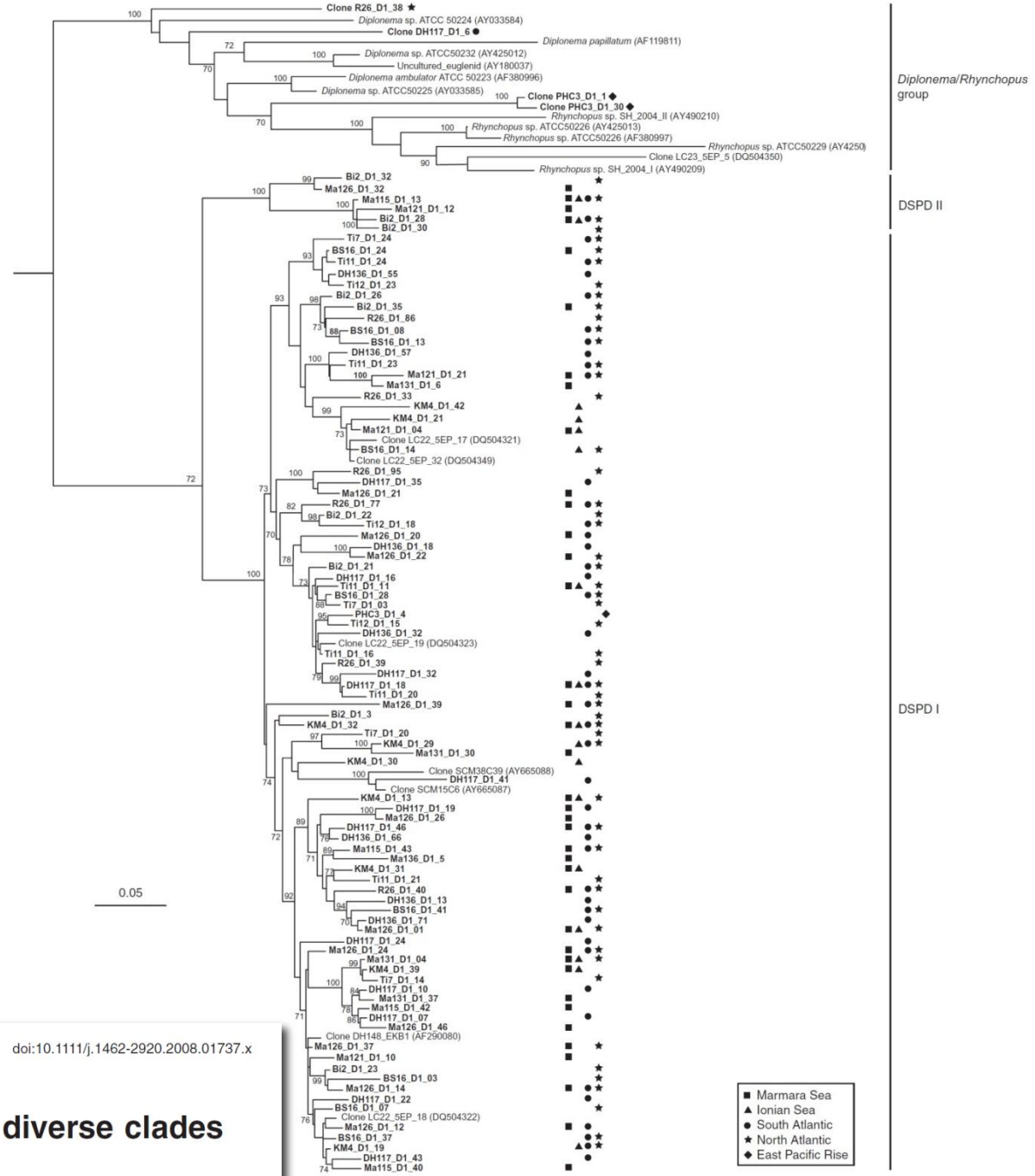


Enrique Lara,[1] David Moreira,[1] Alexander Vereshchaka[2] and Purificación López-García[1]*

Environmental Microbiology (2009) **11**(1), 47–55 doi:10.1111/j.1462-2920.2008.01737.x

Pan-oceanic distribution of new highly diverse clades of deep-sea diplonemids

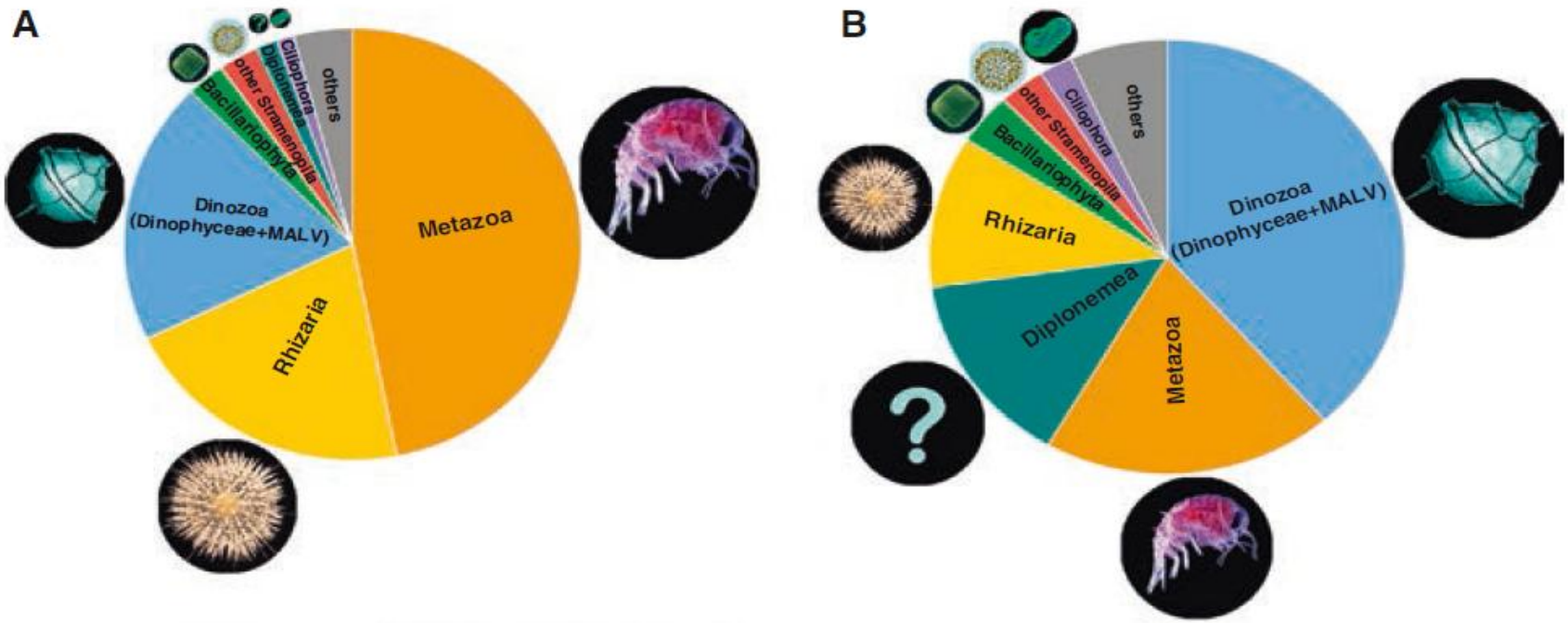
year	authors	location	depth, m
2001	Lopez-Garcia et al.	Drake passage	*3000*
2007	López-García et al.	North Atlantic Ocean	*750*
2007	Countway et al.	North Atlantic Ocean	*125, 2500*
2009	Lara et al.	Marmara Sea	*15 - 1250*
2009	Lara et al.	Ionian Sea	*3000*
2009	Lara et al.	South Atlantic Ocean	*5 - 1000*
2009	Lara et al.	North Atlantic Ocean	*2280 - 3500*
2009	Lara et al.	East Pacific Rise	*1695*
2010	Sauvadet et al.	Pacific Ocean	*500, 900*
2010	Scheckenbach et al.	South Atlantic Ocean	*5000*
2011	Eloe et al.	Puerto Rico Trench	*6000*

156 diplonemid SSU sequences in GenBank:

8 *Diplonema* spp.

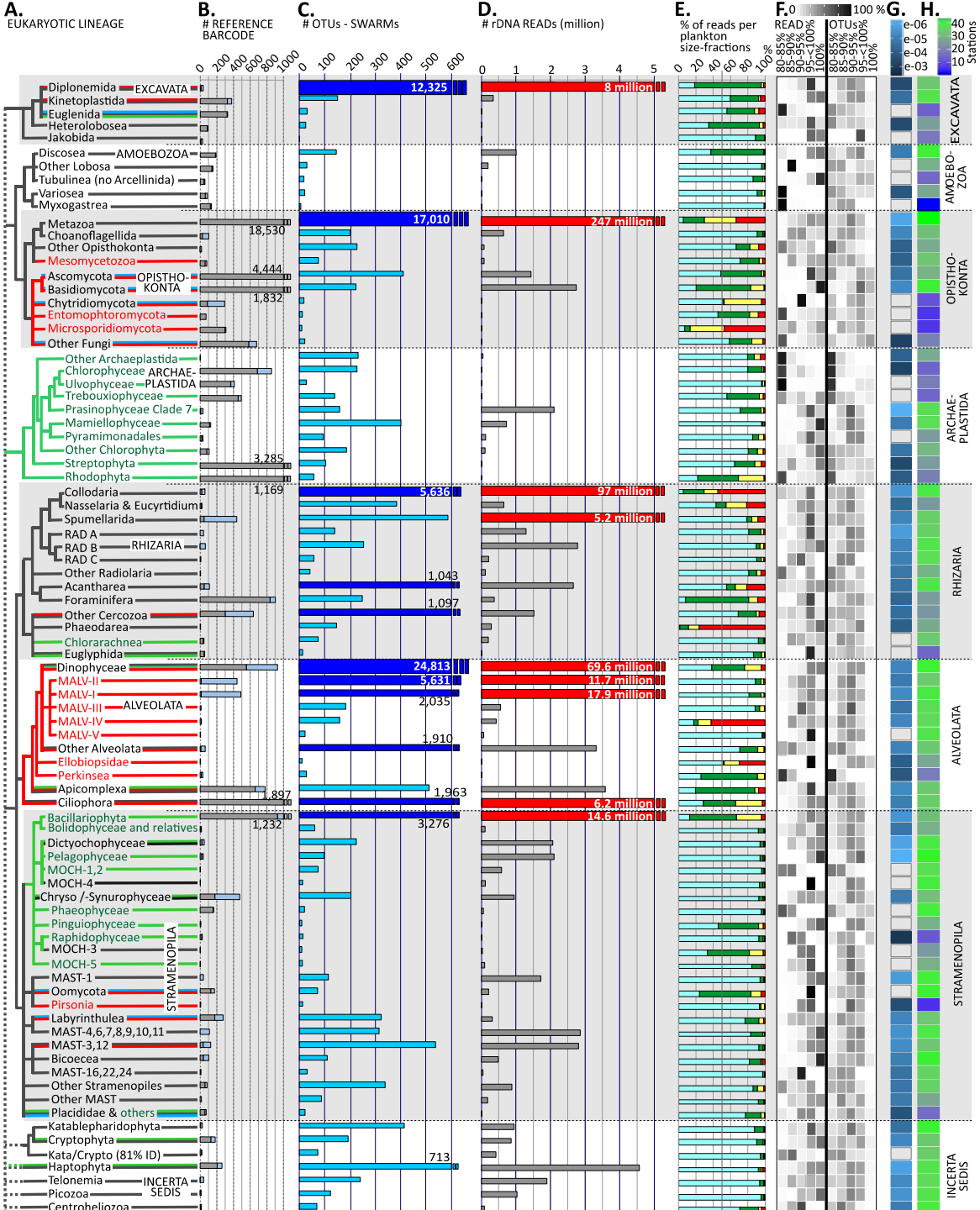
6 *Rhynchopus* spp.

142 environmental sequences



But diplonemids are the 3rd most diverse and 6th most abundant eukaryote in the world oceans!

Lukeš, Flegontova, Horák, Curr. Biol. in press



... a few surprises there, e.g. low counts of streptophytes and haptophytes, only diatoms and dinos significant among primary producers.

Obvious winners – metazoans and dino. Amazingly diverse & abundant Rhizarians but first and foremost, **Diplonemids**.

All this in photic zone, but they are deep ,too

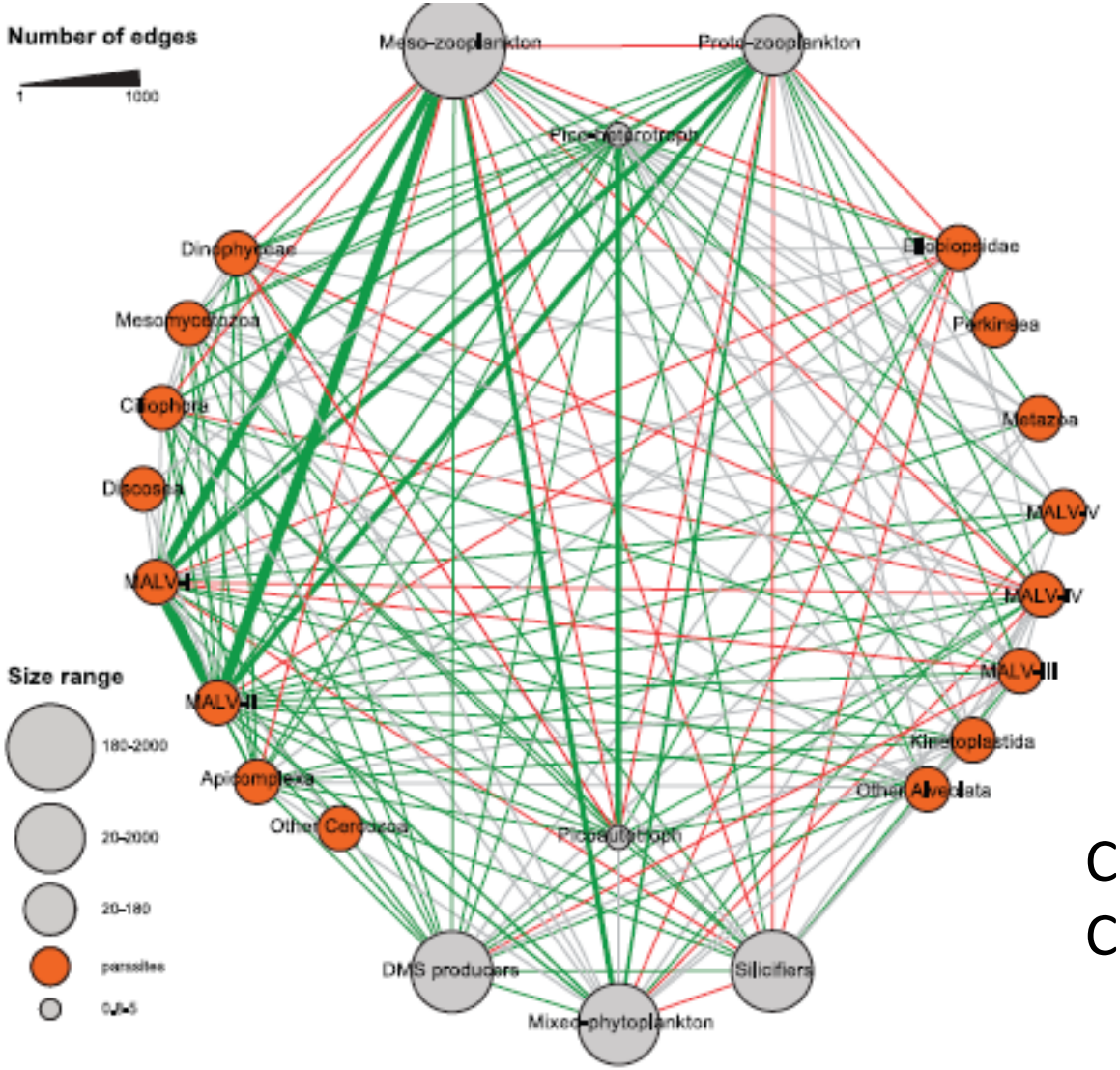
de Vargas et al. Science, 2015

WHAT ARE THEY DOING THERE?

~~phototrophs?~~

heterotrophs

parasites
symbionts
predators
detritovores
bacteriovores
...

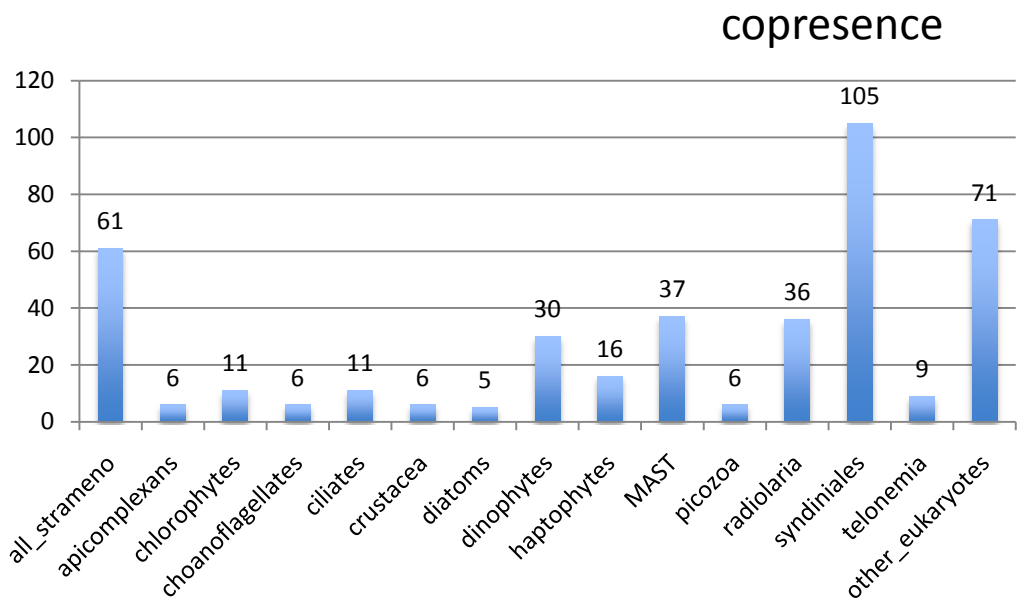


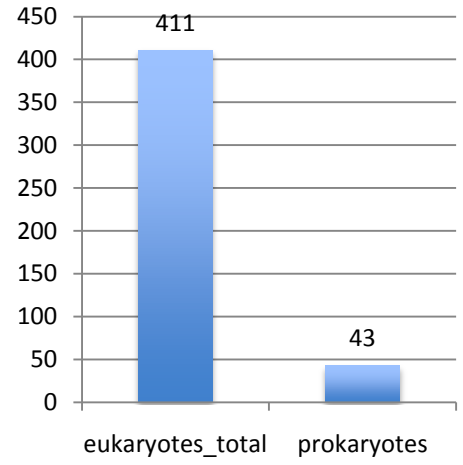
Co-occurrence plot says very little if anything in case of diplonemids

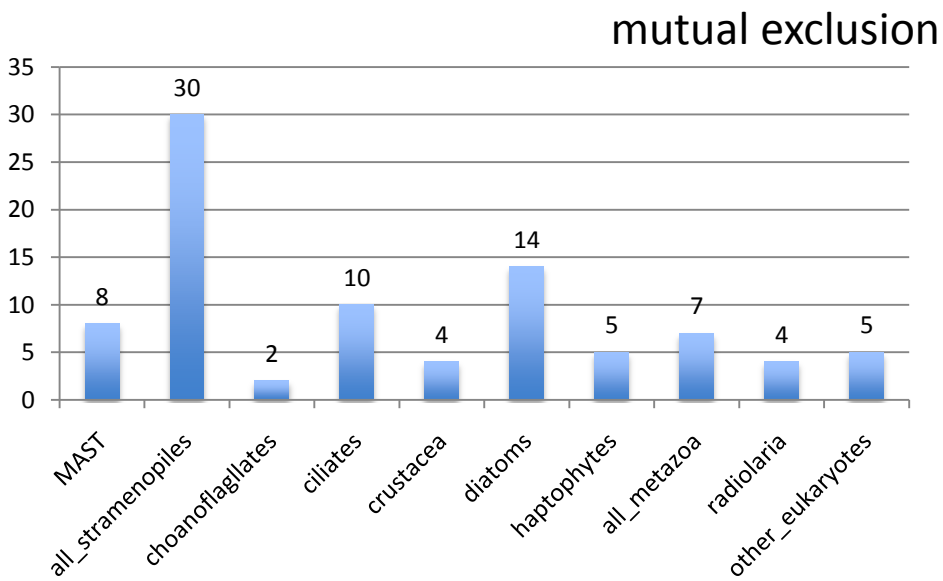
Co-presences (green)
Co-exclusions (red)

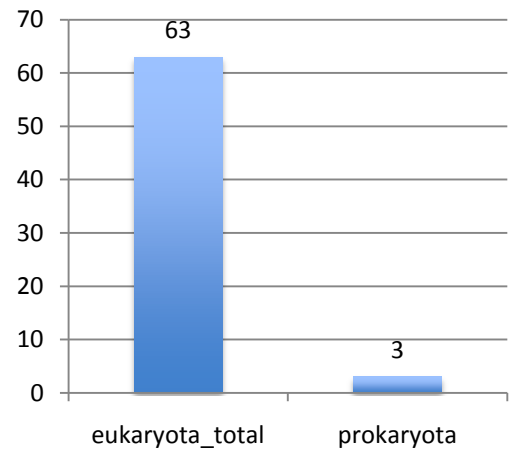
Lima-Mendez et al, Science 2015

In-silico estimates of interactions, general numbers









Conclusions

- **A clade sister to classic diplonemids is the most abundant group of Excavata in the World Ocean plankton.**

- **As compared to other eukaryotes, it emerges as a hyper-diverse clade, the third by the number of OTUs after dinoflagellates and metazoans.**

- **Marine planktonic diplonemids reach very high relative abundance in some stations of the deep non-photic zone, in small size-fractions up to 20 µm.**

- **This huge group represents an overlooked major player in marine ecosystems, however, nothing is known about their morphology and lifestyle.**

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