Eukaryotes (that aren’t plants, animals, or fungi)

Most eukaryotes are protists (single-celled)

Lots of diversity in nutrition and reproduction/life cycles

Eukaryotes are divided into broad “Supergroups” based on molecular and morphological data (these are a bit fluid these days)

SAR – Archiplastida – Excavata – Amoebozoa – Opisthokonta

Secondary endosymbiosis

Ecological importance of protists

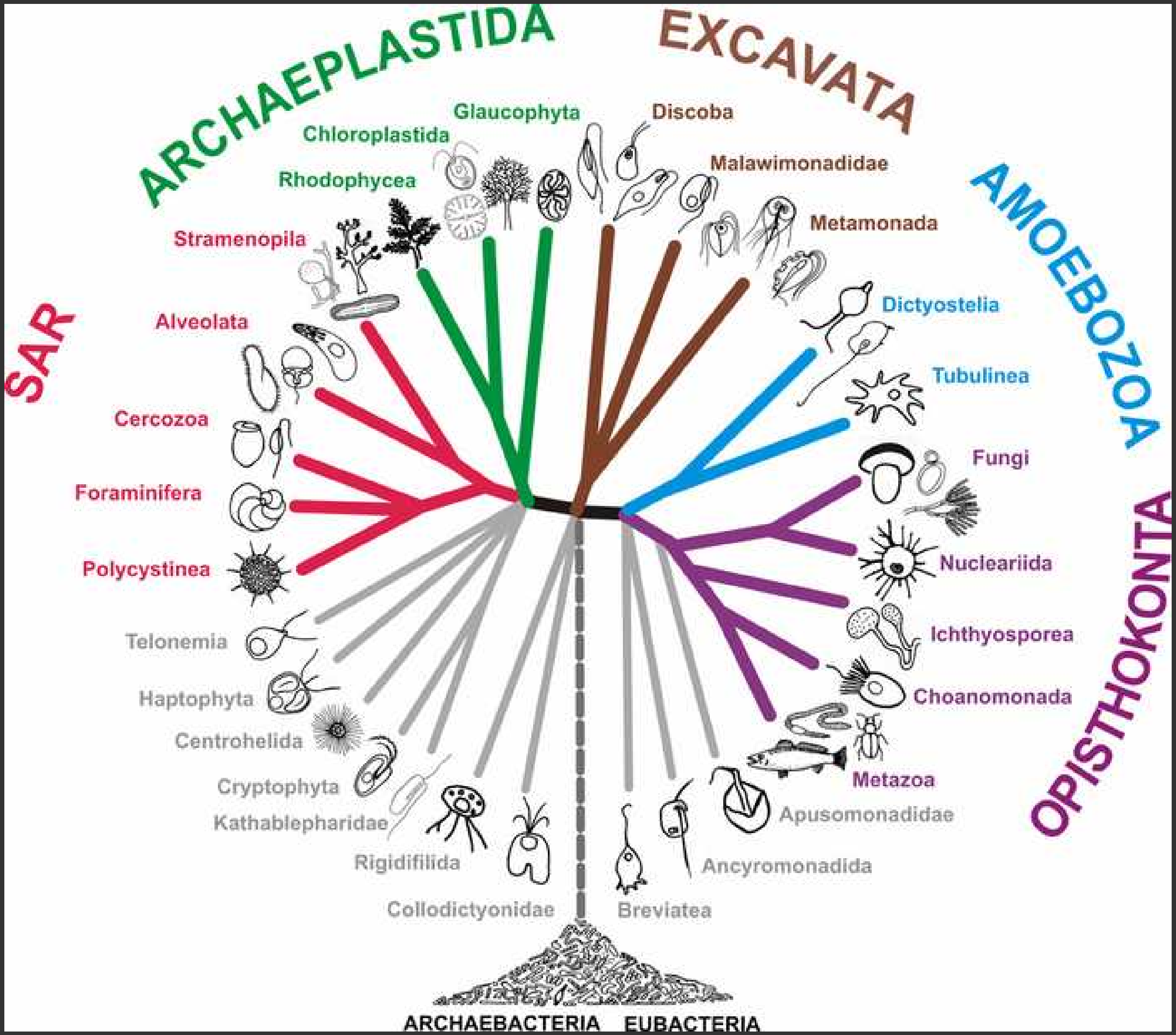
Nature of Science

Facts: Observations

Laws: Detailed descriptions of some aspect of nature based on repeated observation

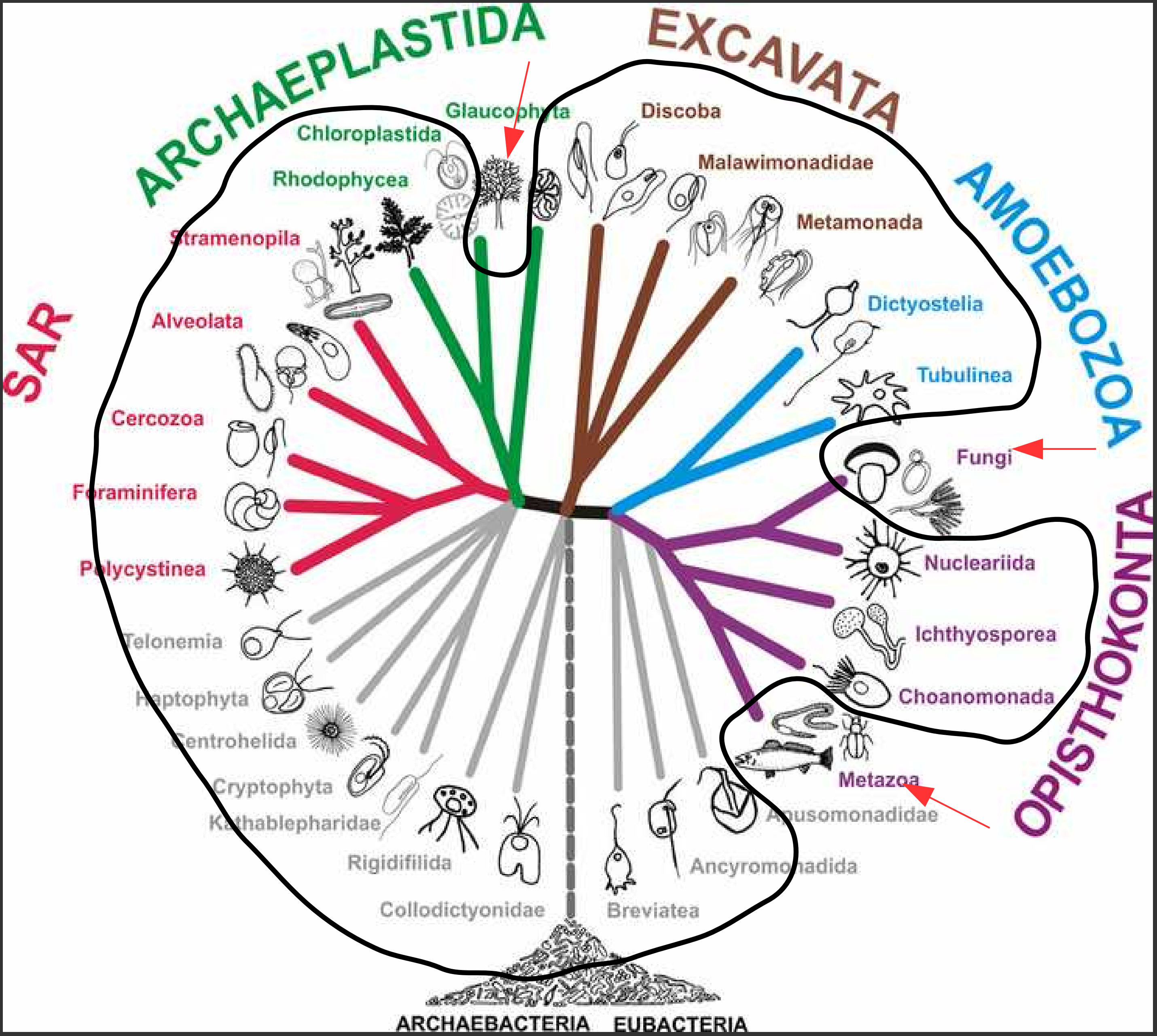
Hypotheses: A testable and falsifiable *explanation* of observation

Theory: Detailed *explanation* for observations that has passed countless tests and makes useful predictions



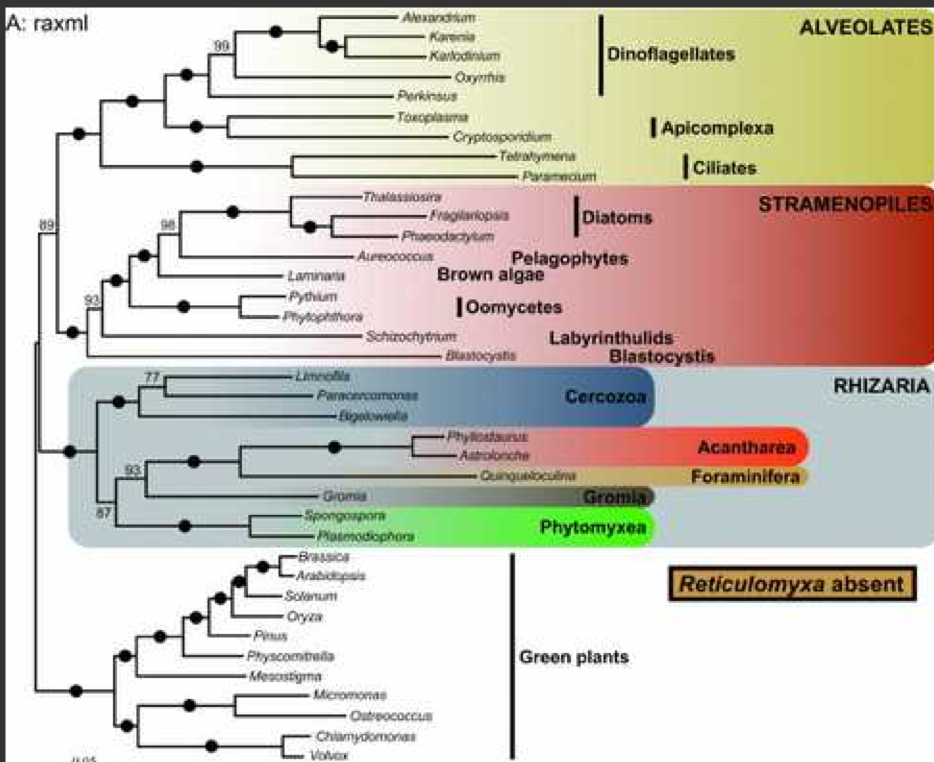
http://bit.ly/2jtb3og

Quick recap on what a protist is:

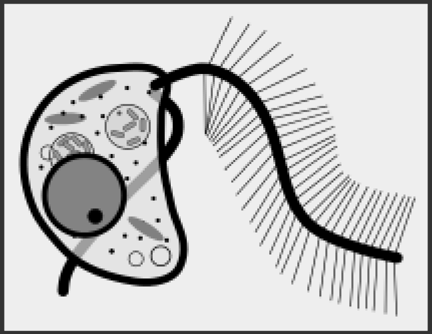


SAR

“Stramenopiles, Alveolates, and Rhizarians”

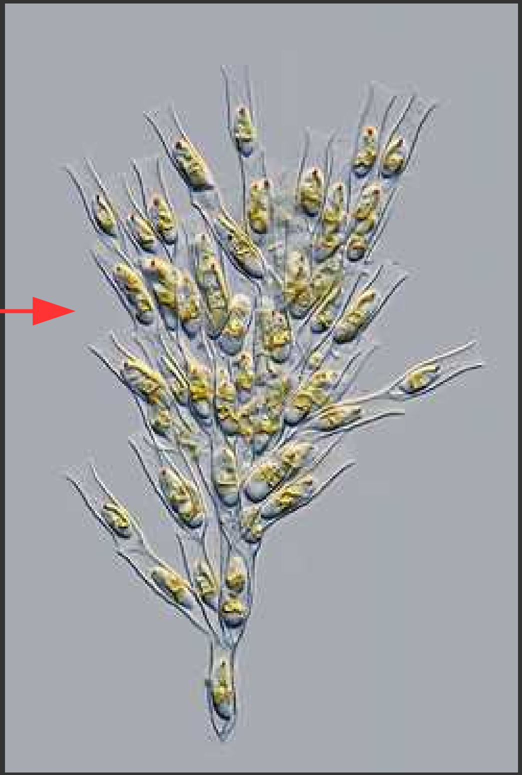


Stramenopiles

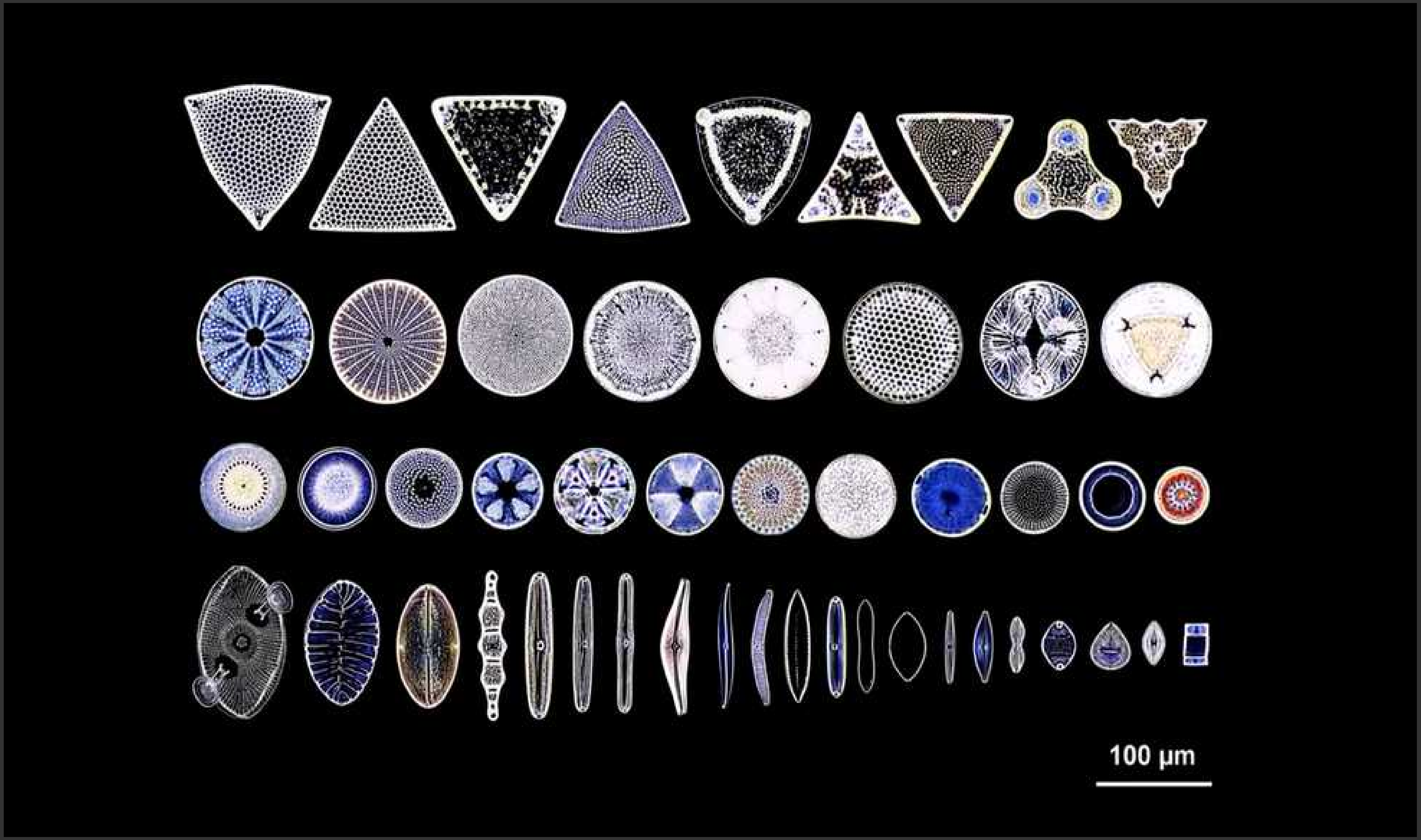


Diatoms

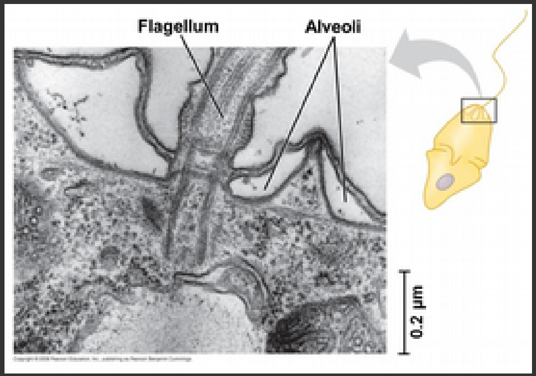
Golden Algae



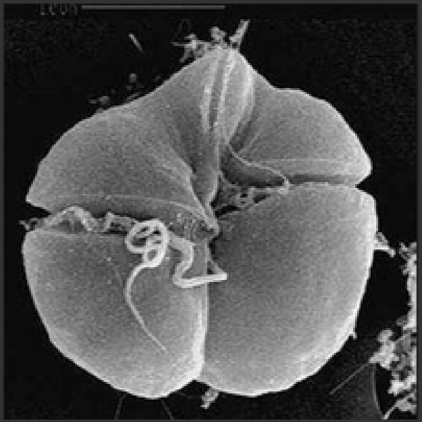
Brown Algae


100 µm

Alveolates

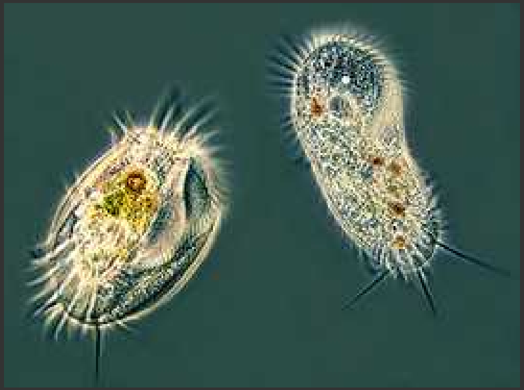


Dinoflagellates
(responsible for "red tides")



Apicomplexans
(obligate parasites of animals)

Ciliates

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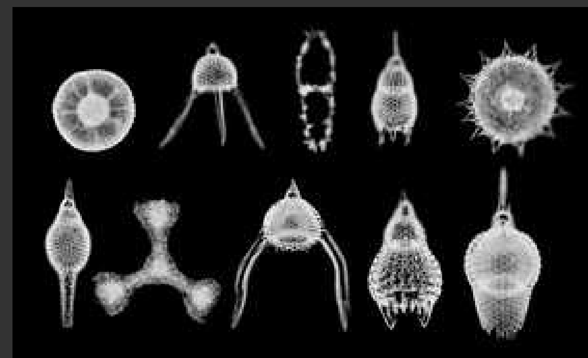
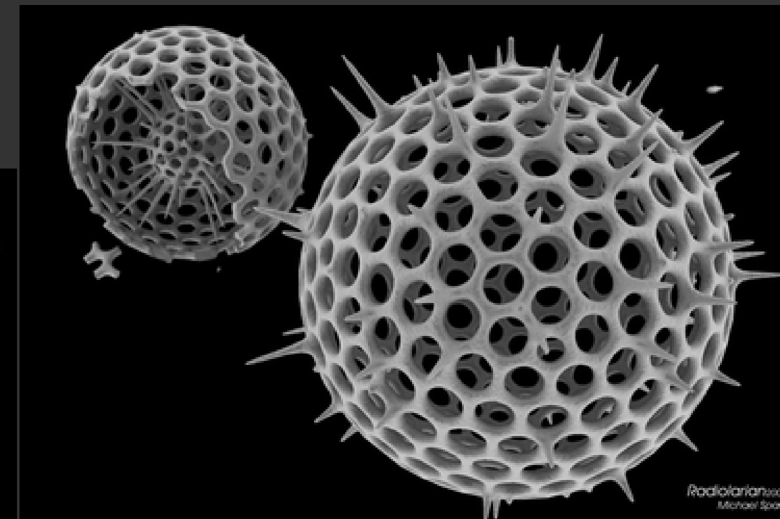
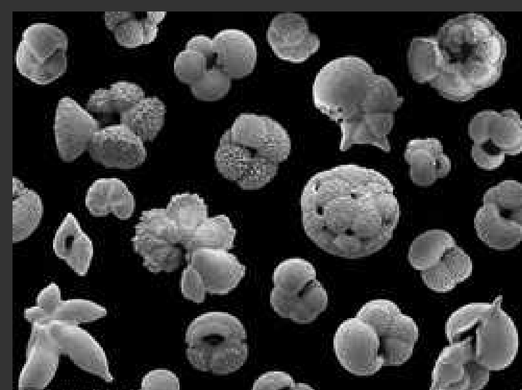
Rhizarians

Radiolarians

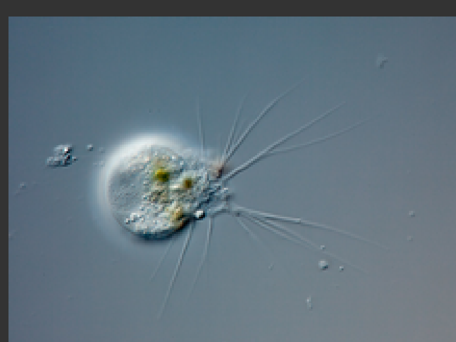




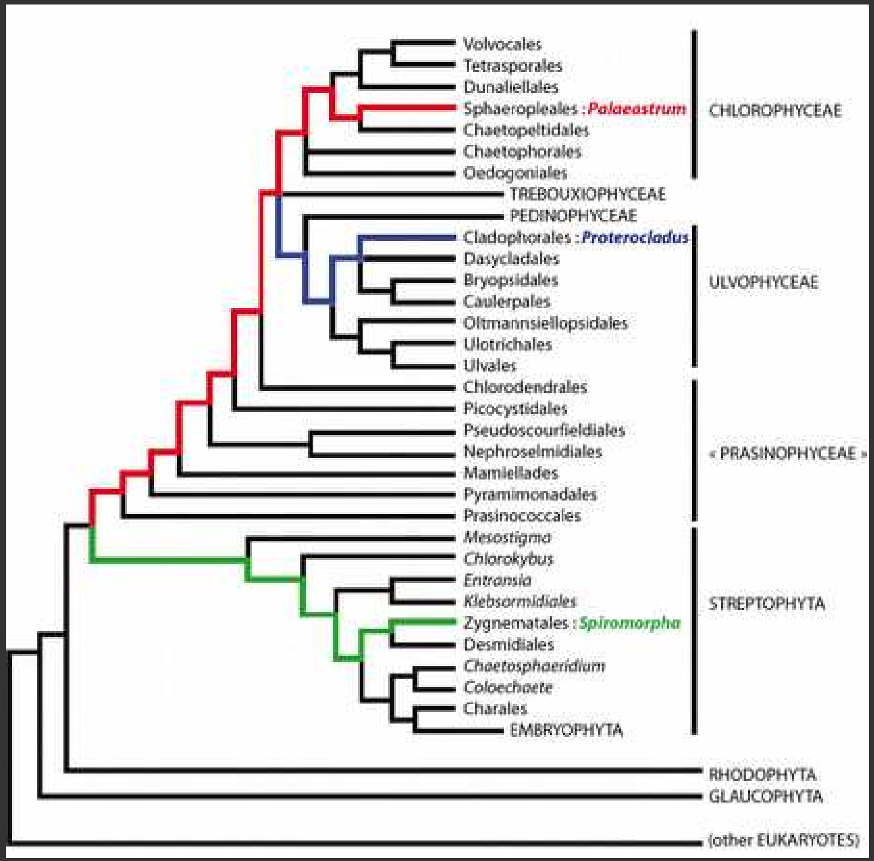
Foraminiferans



Cercozoans

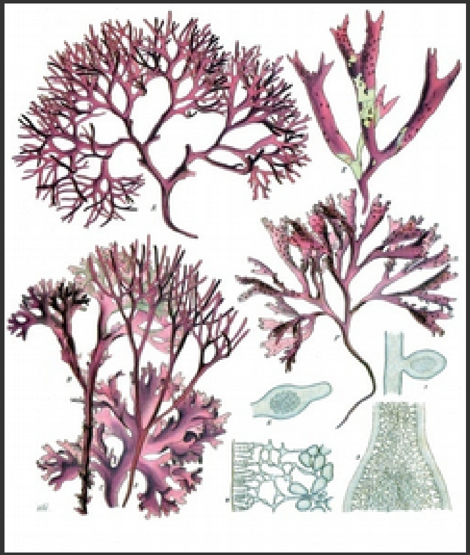


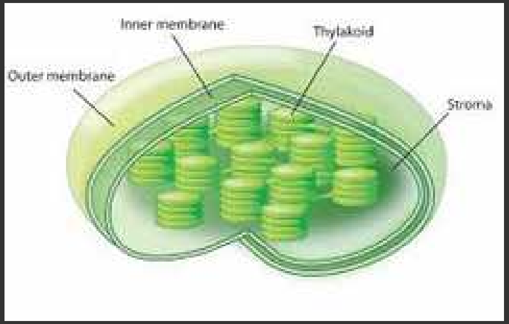
Archiplastida



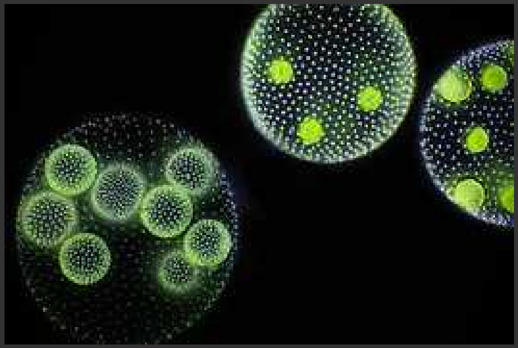
Archiplastids
Grouped due to same plastid origin

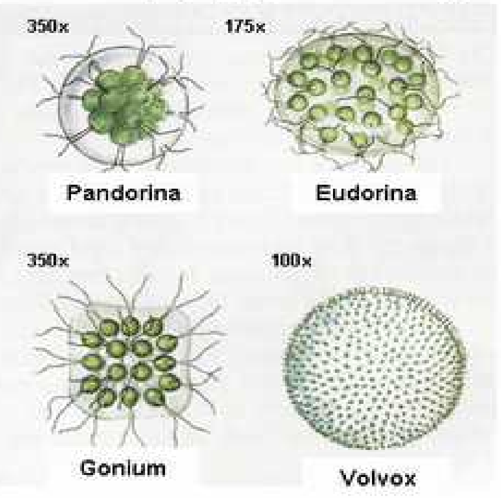
Red Algae
"Rhodophytes"





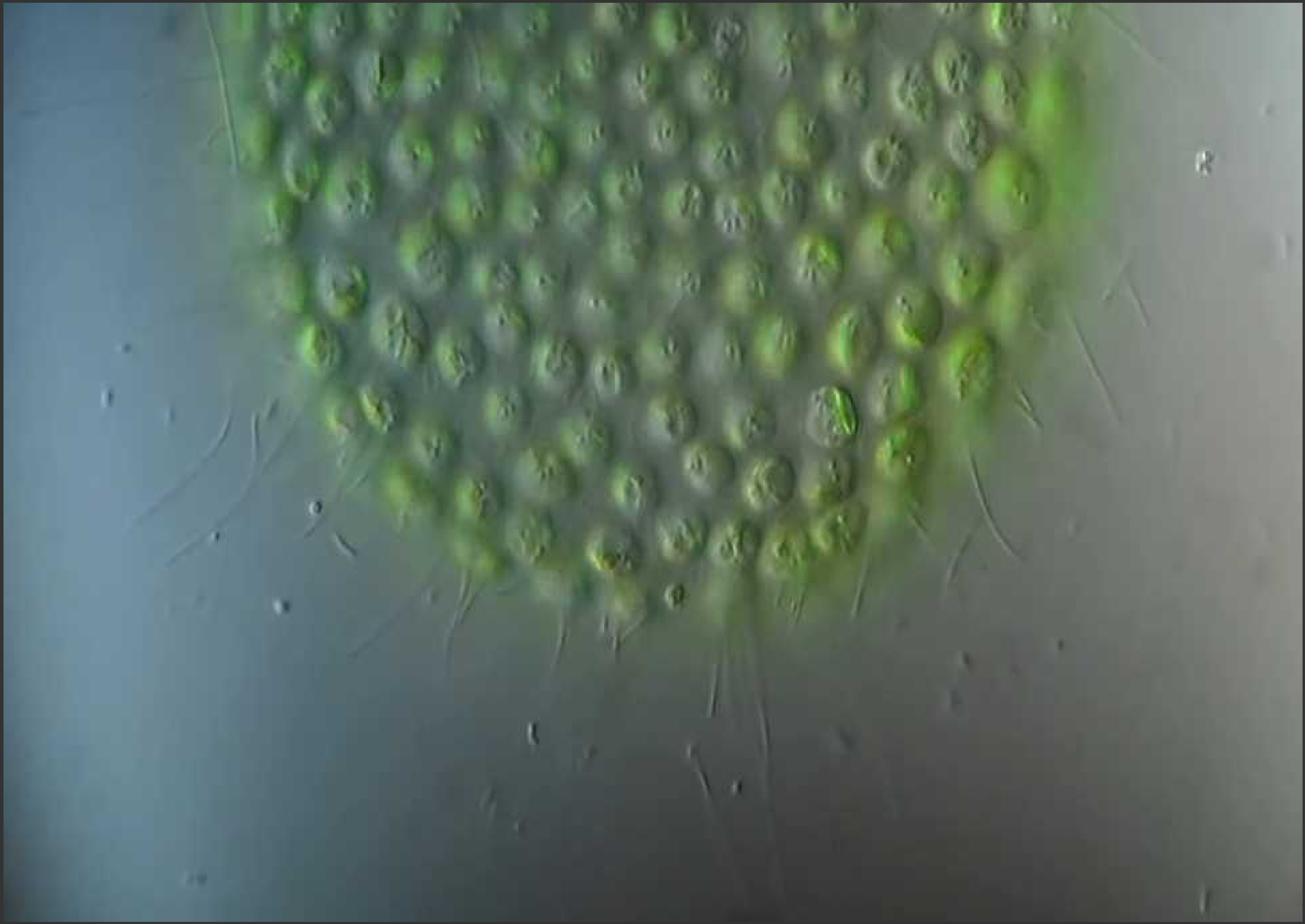
Green Algae
"Chlorophytes/Charophytes"

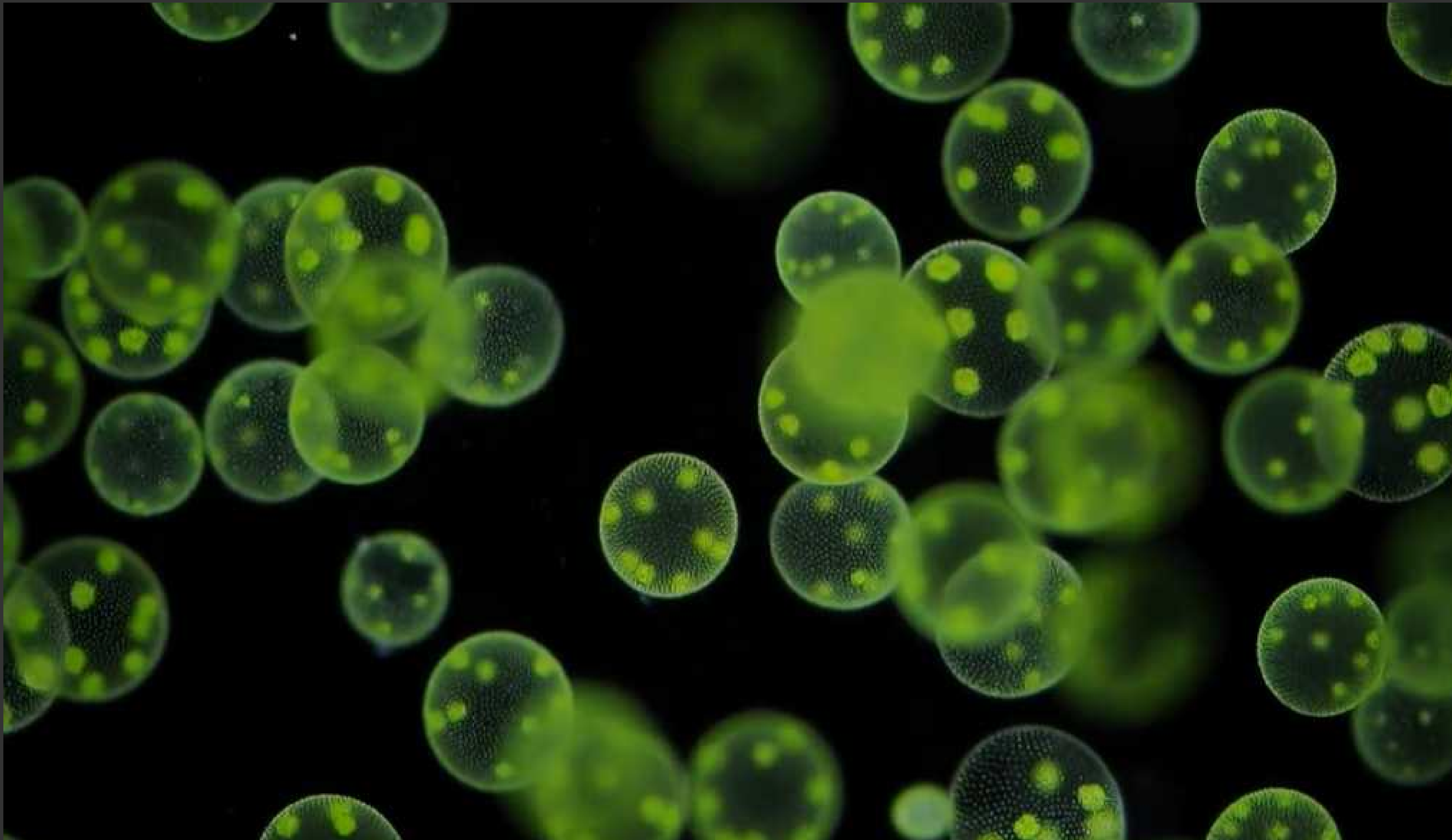




Streptophytes
"Plants"

We will deal with plants later.

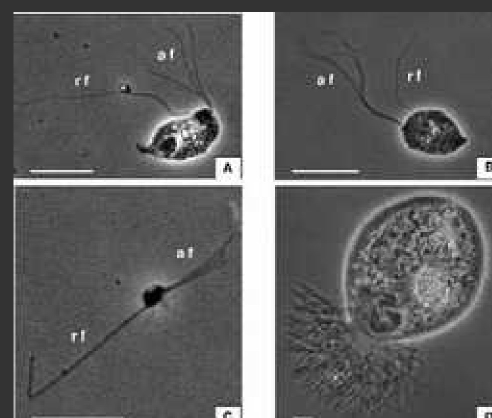




Excavata

Diplomonads
(reduced mitochondria)

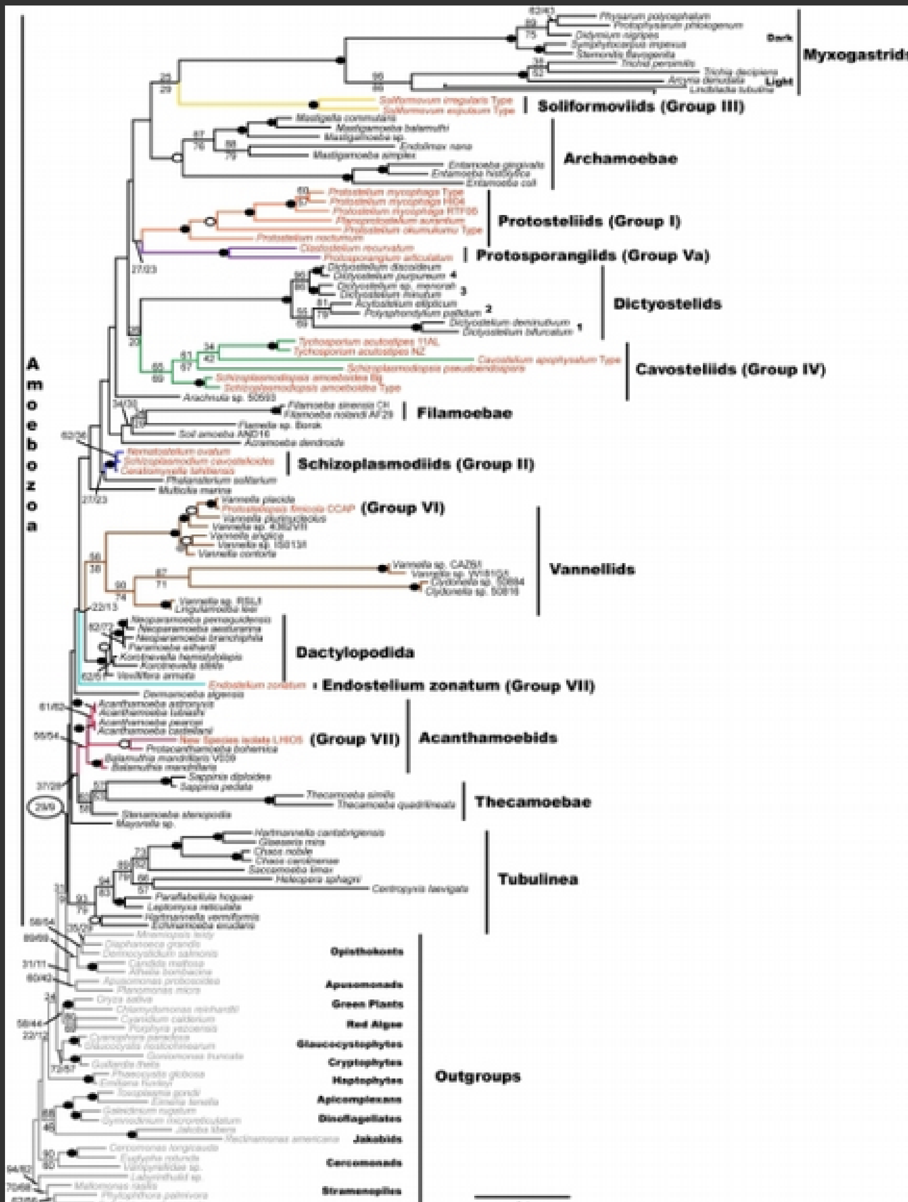
Parabasilids
(very reduced mitochondria)



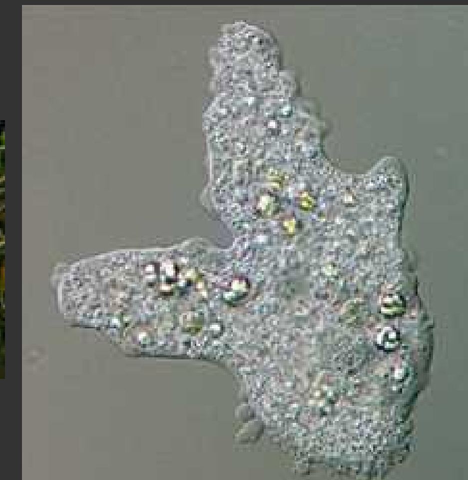
Euglenozoans
(very diverse group tied together
By flagella morphology)

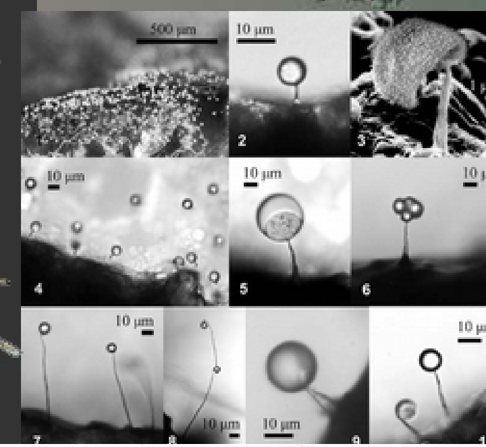
Euglena video

Amoebozoa

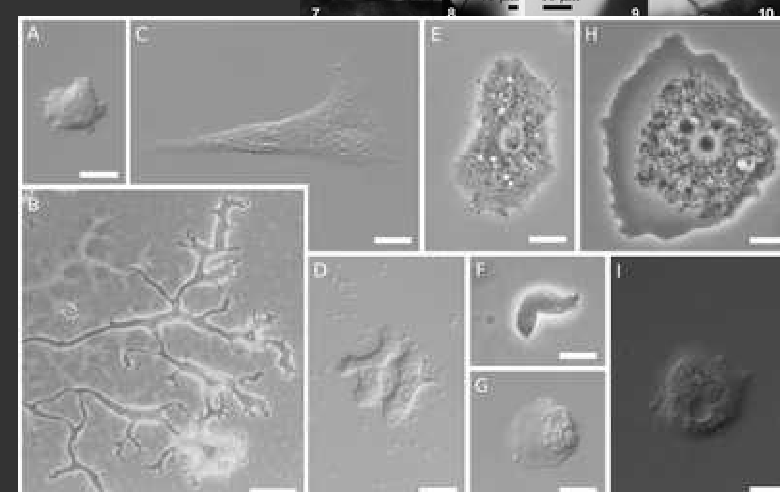


Myxogastrids
Dark
Light
Soliformoviids (Group III)
Archamoebae
Protosteliids (Group I)
Protosporangiids (Group Va)
Dictyostelids
Cavosteliids (Group IV)
Filamoebae
Schizoplasmodiids (Group II)
(Group VI)
Vannellids
Dactylopodida
Endostelium zonatum (Group VII)
(Group VII)
Acanthamoebids
Thecamoebae
Tubulinea
Opisthokonts
Apusomonads
Green Plants
Red Algae
Glaucocystophytes
Cryptophytes
Haptophytes
Apicomplexans
Dinoflagellates
Jakobids
Cercomonads
Stramenopiles
Outgroups
Amoebozoa
0.1





500 µm
10 µm
1 µm
1
2
3
4
5
6
7
8
9
10

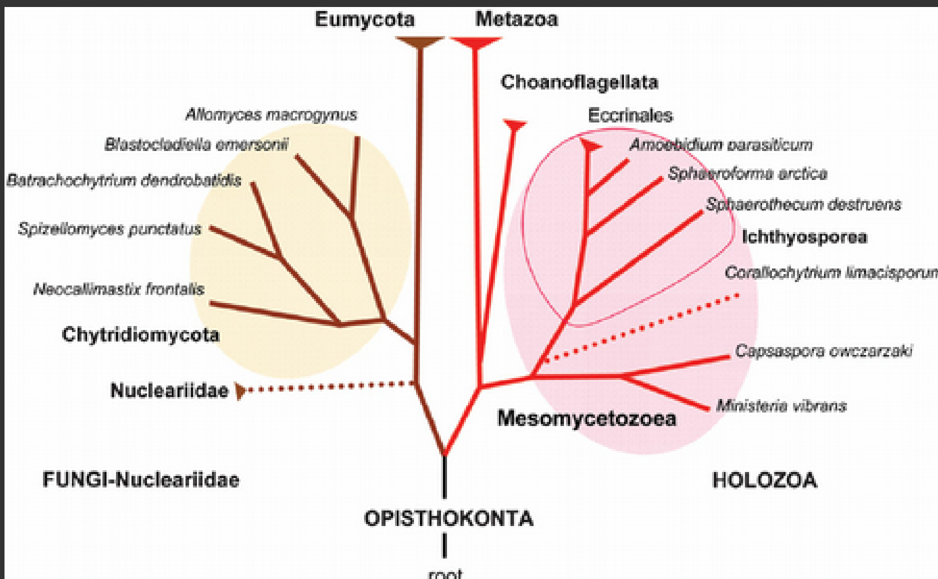


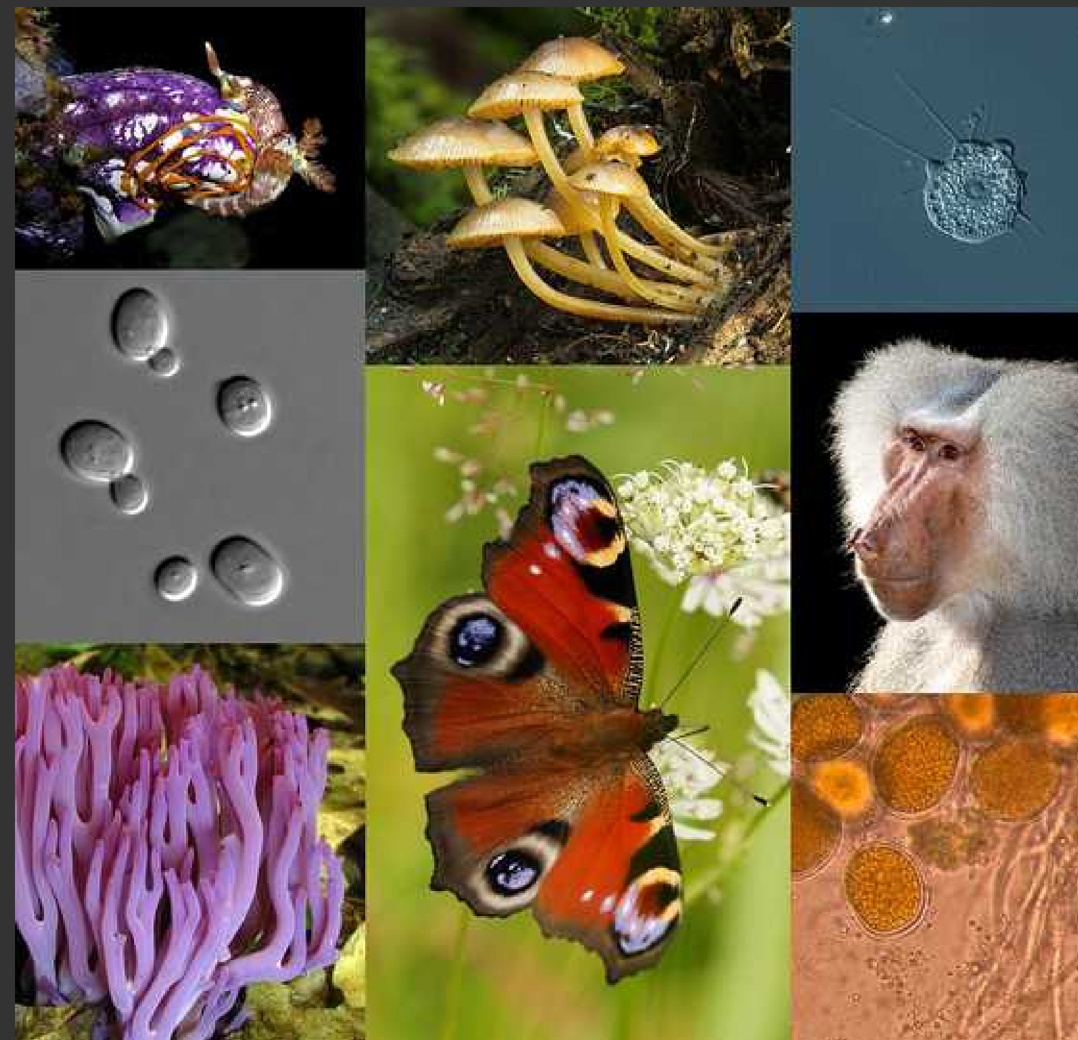
A
B
C
D
E
F
G
H
I


CORNELL UNIVERSITY

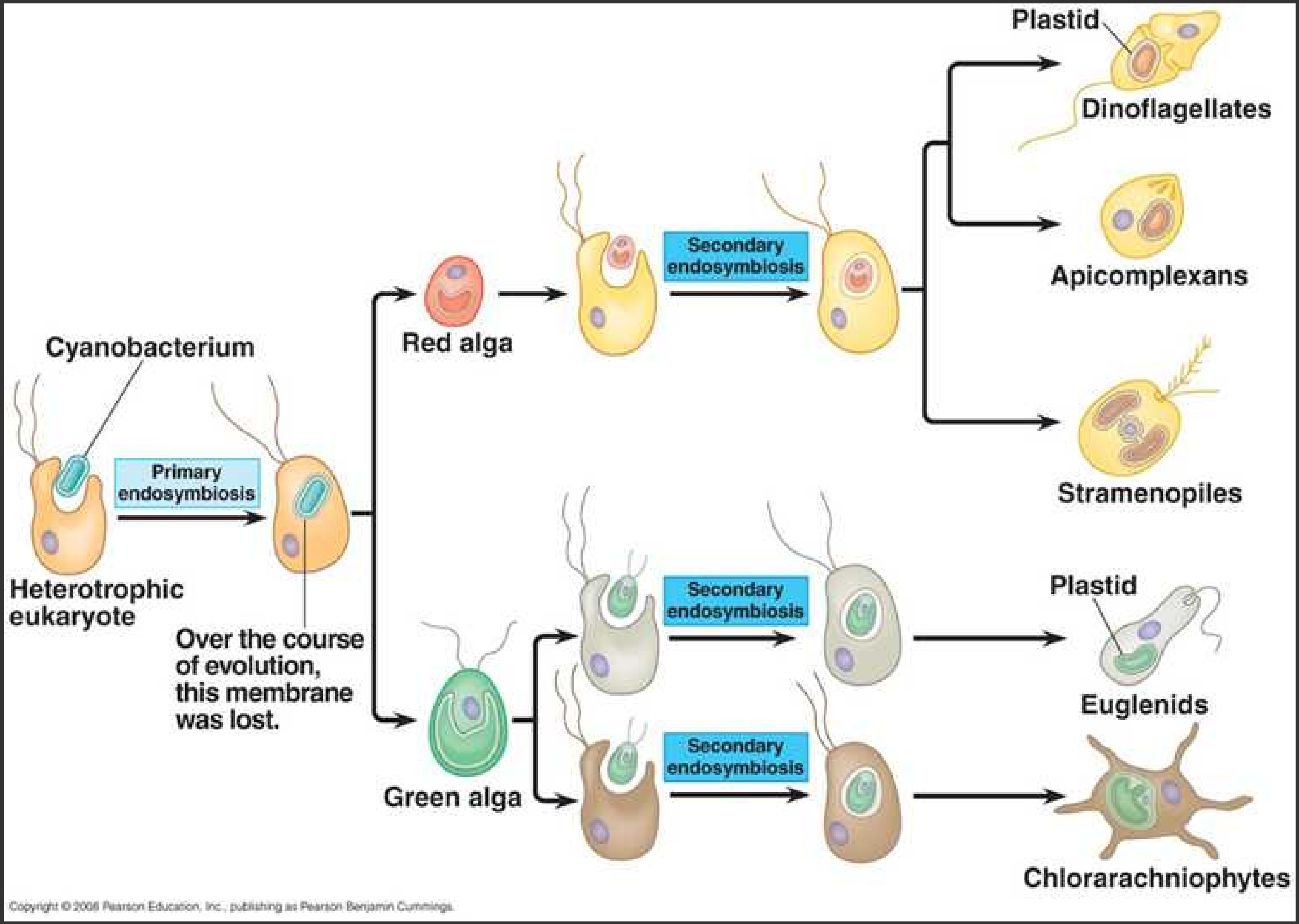

0.5
mm

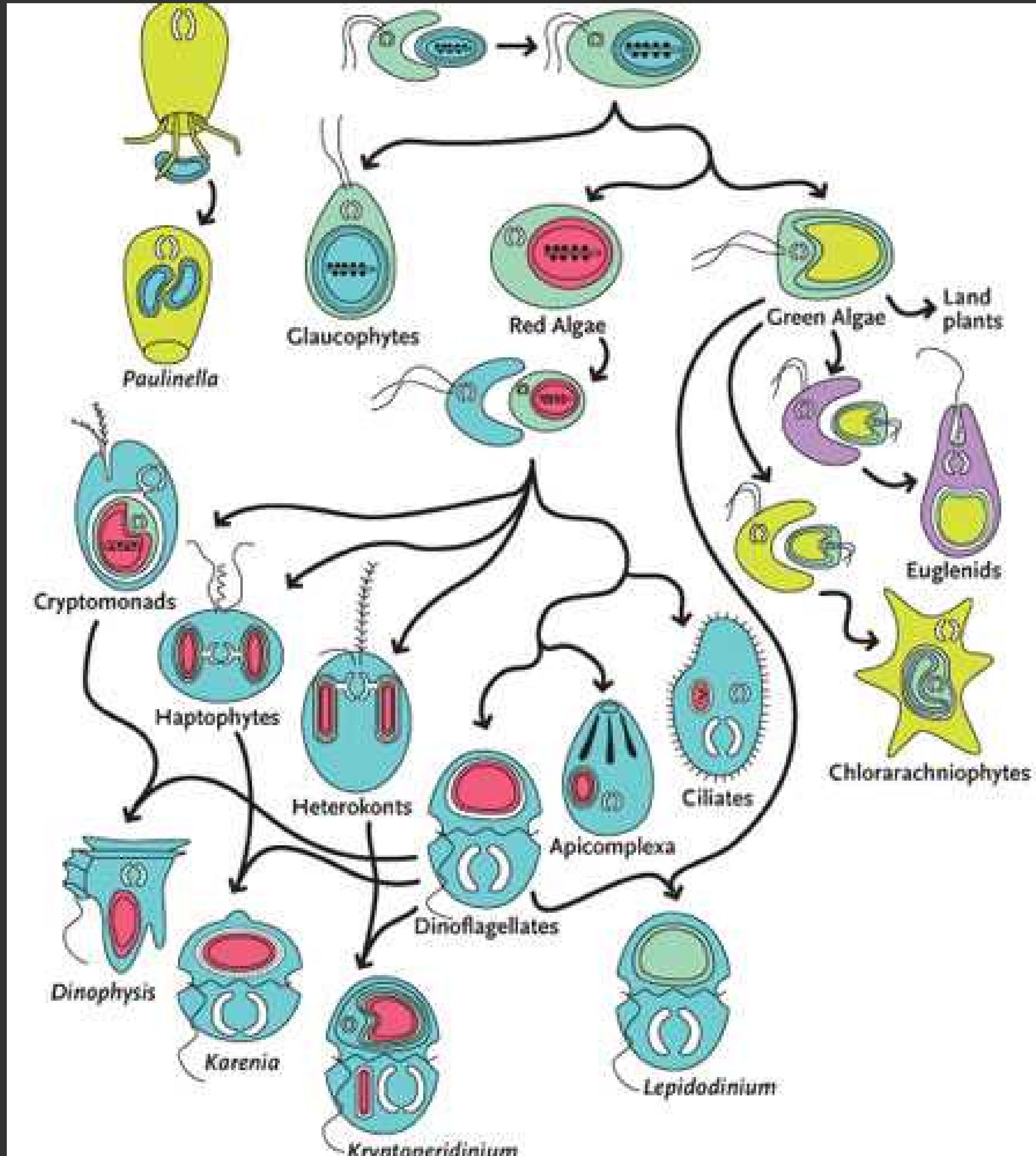
Opisthokonta





Endosymbioses





Paulinella
Glaucophytes
Red Algae
Green Algae
Land plants
Euglenids
Cryptomonads
Haptophytes
Heterokonts
Ciliates
Apicomplexa
Chlorarachniophytes
Dinoflagellates
Dinophysis
Karenia
Kryptoperidinium
Lepidodinium

Importance of protists

Why was there mass immigration of Irish people to the US in the 1840s?

Why does overuse of fertilizer lead to deadly “red tides” in the Gulf of Mexico?

Why do sickle-cell heterozygotes have an advantage in sub-Saharan Africa?

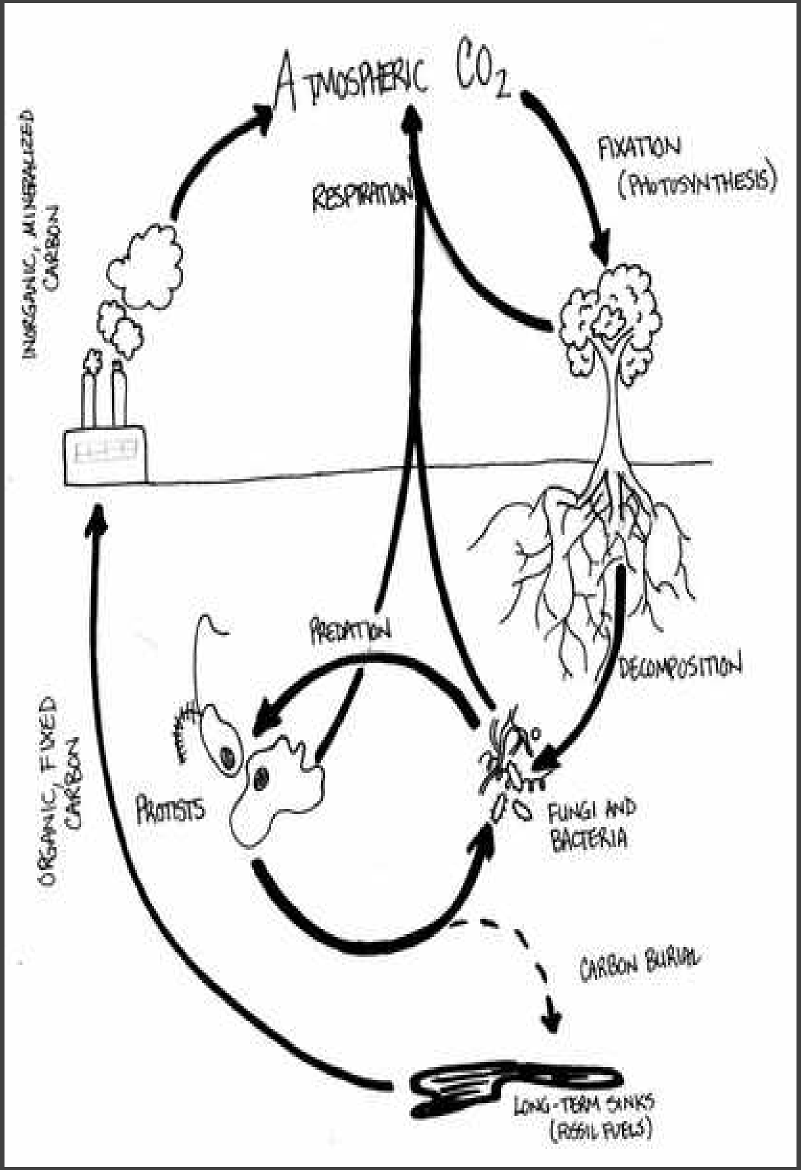
Why does warmer ocean water lead to coral bleaching and die-off?

How will the first biological computer chips be grown?

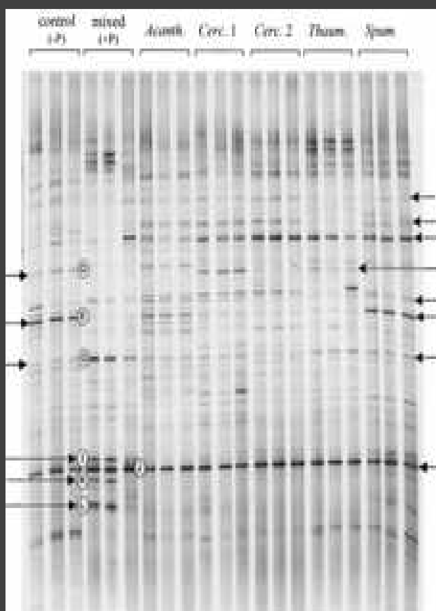
How does warming increase respiration rates of soil bacteria?

Amoebae and the microbial loop

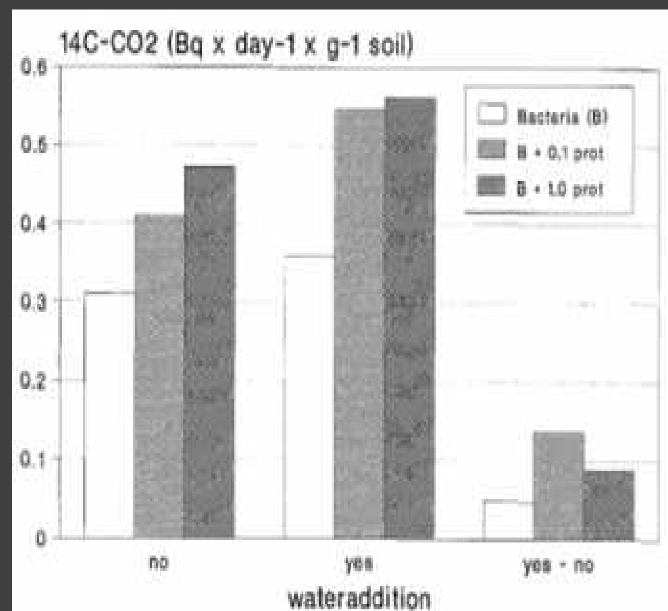
- Amoebae are the most abundant bacterivorous protists in virtually every soil system examined
- Predation pressure results in changes to the bacterial community (compositional and physiological)
- "Sloppy feeding" releases unincorporated nutrients into the soil, stimulating bacterial and plant growth
- They consume 200 – 1500 bacterial cells • amoeba^{-1} • hr^{-1}



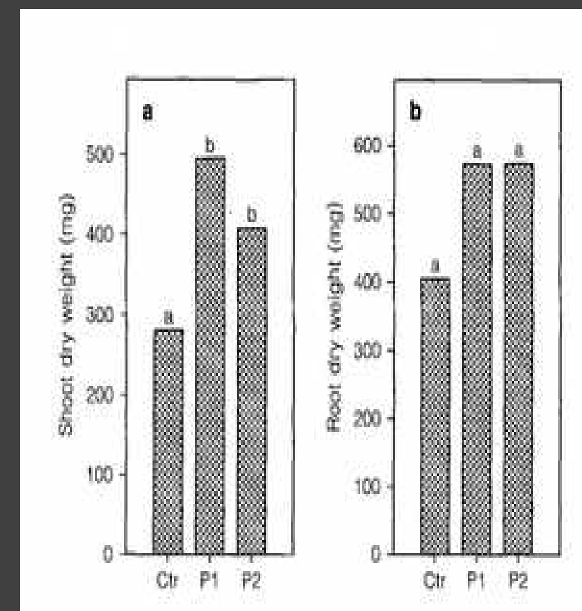
Protist predators have a strong influence on…



Rønn 2002



Kuikmann 1990



Jentschke 1995

Bacterial community

C-mineralization

Plant growth

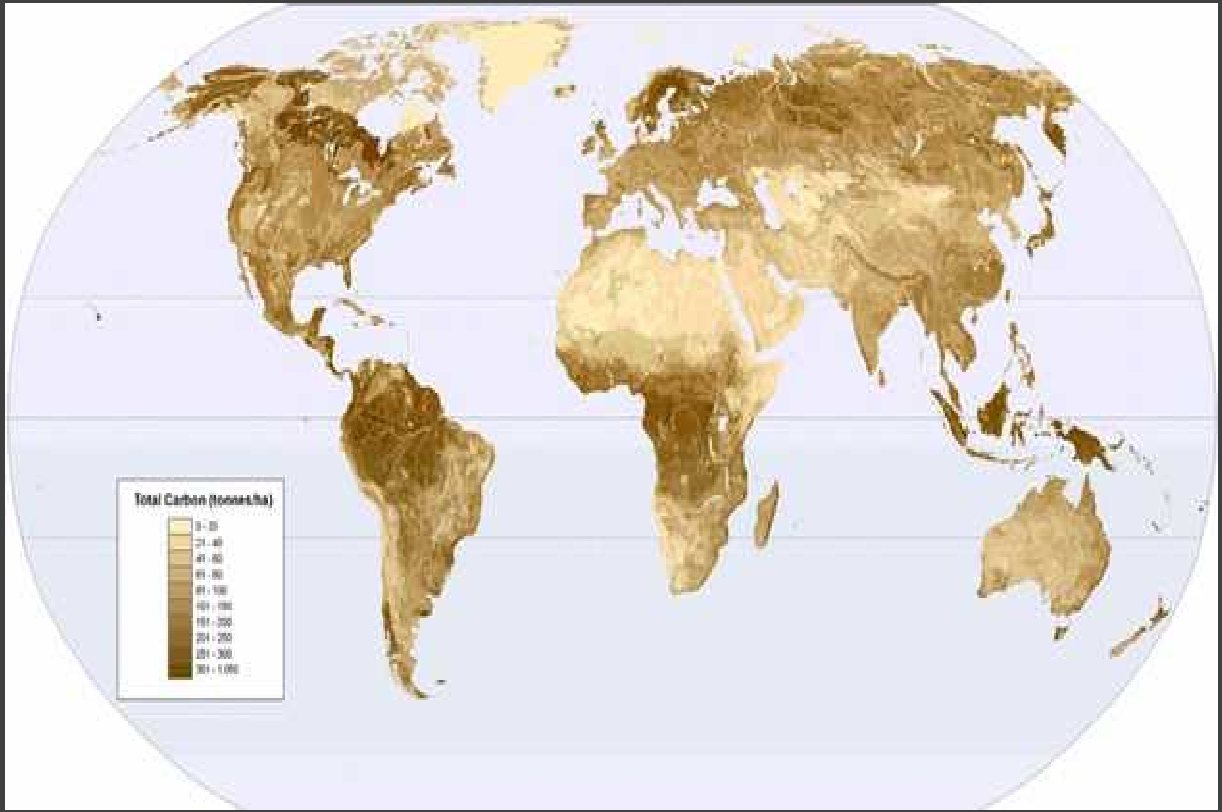
Predicting the fate of soil carbon…

In terrestrial systems, soils are the ultimate destination for most fixed carbon (C)

2700 Pg (10^{15}) globally, or more than 3x atmospheric C

60 Pg of turnover annually

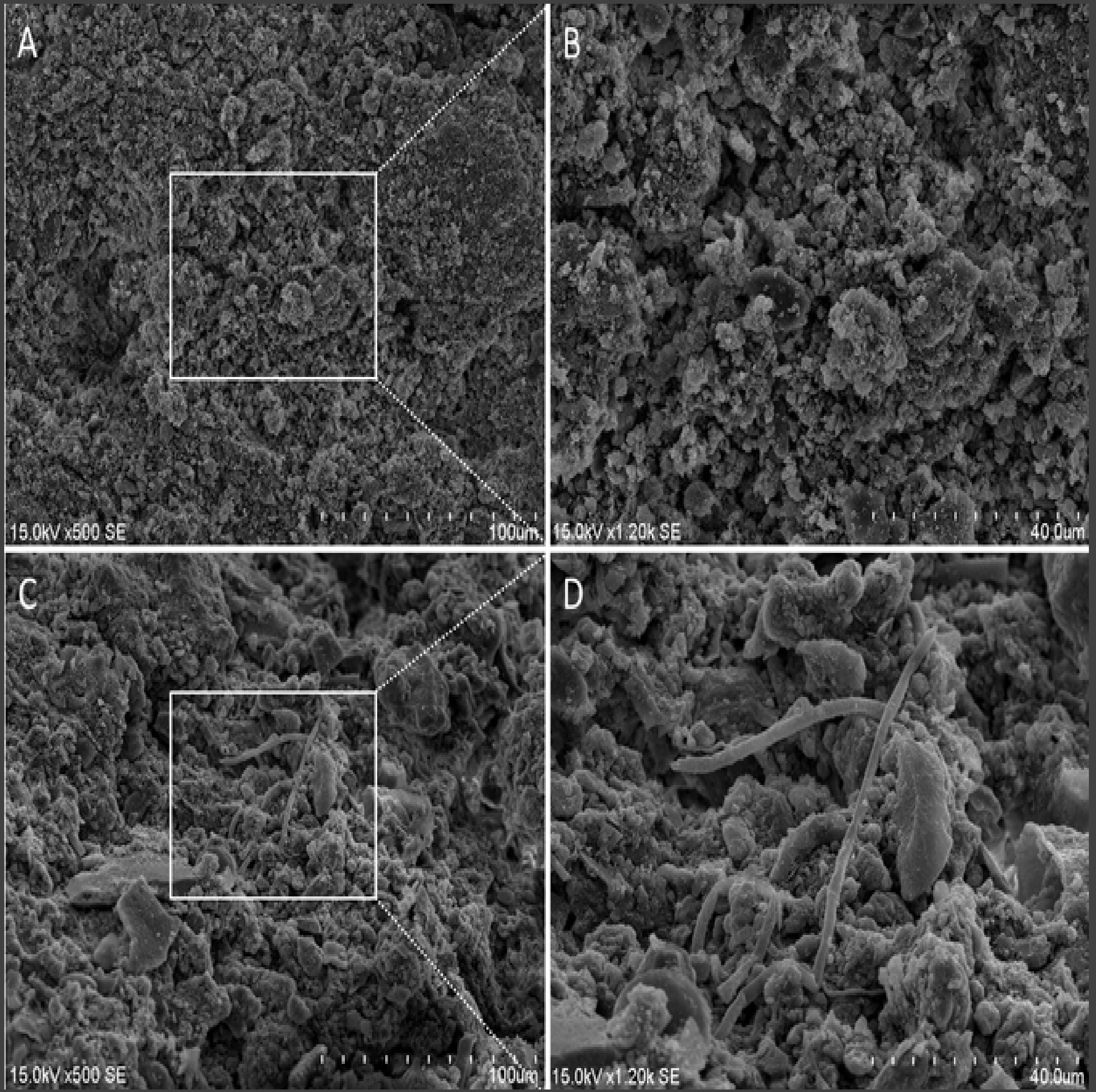
The rate of decomposition is controlled by a variety of factors, including <u>microbial activity</u> and <u>climate</u>



Scharlemann et al., 2011

Soils are complicated (understatement)…

- They are literally opaque
- Highly heterogenous
- Physical structure can sequester biota or OM
- >90% of biota have not been successfully cultured



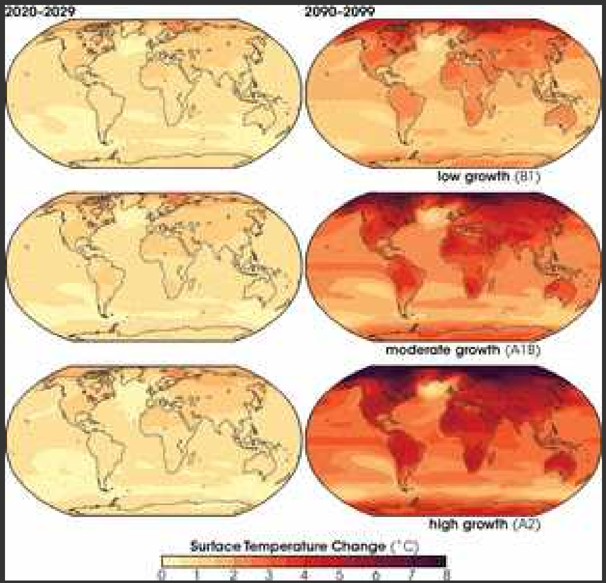
Predicting the fate of soil carbon…

This C is eventually decomposed and returned to the atmosphere

The rate of decomposition is controlled by a variety of factors, including microbial activity and climate

A more mechanistic understanding of the processes at work may improve our predictive models…

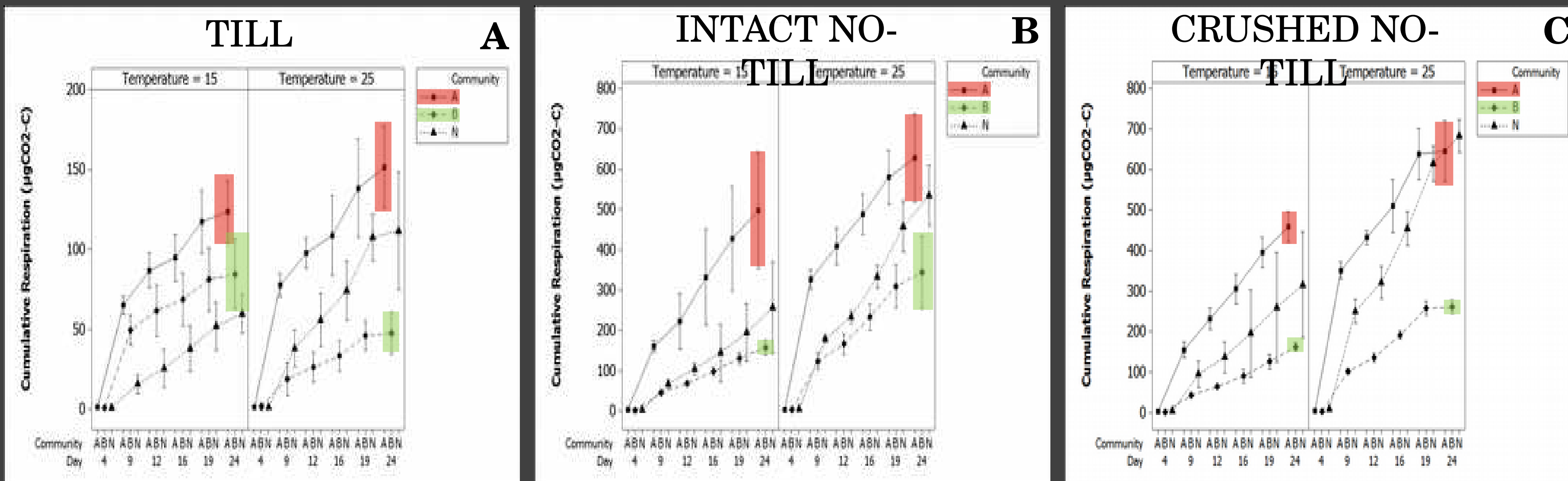
“How do microbial communities and climate and soil variables interact with regards to C turnover?”



IPCC 2007

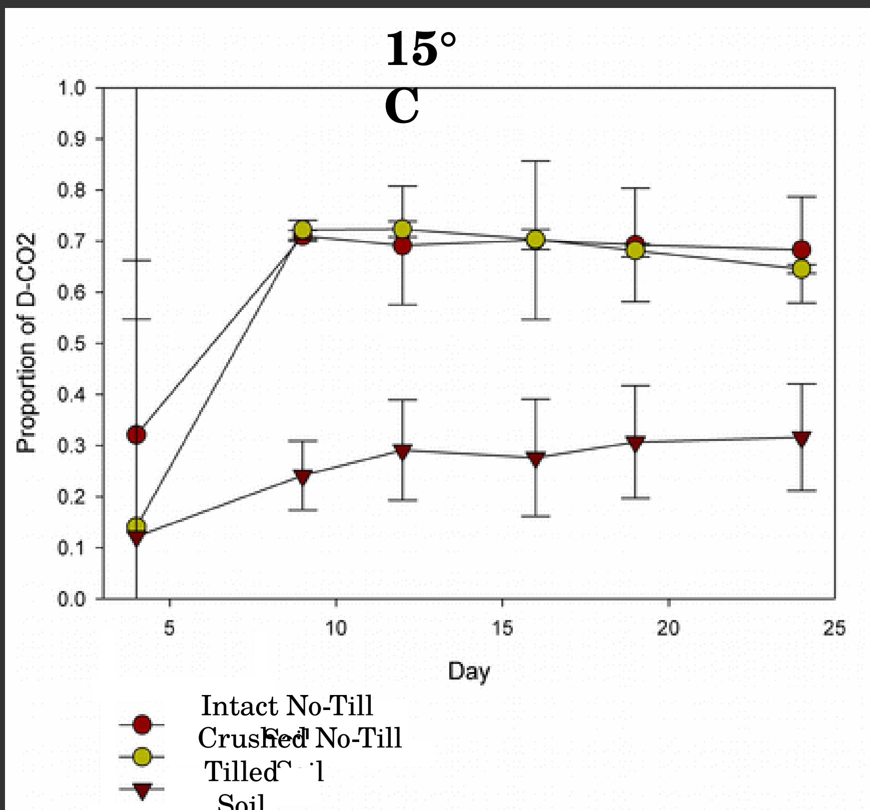
Neumeyer, 1998

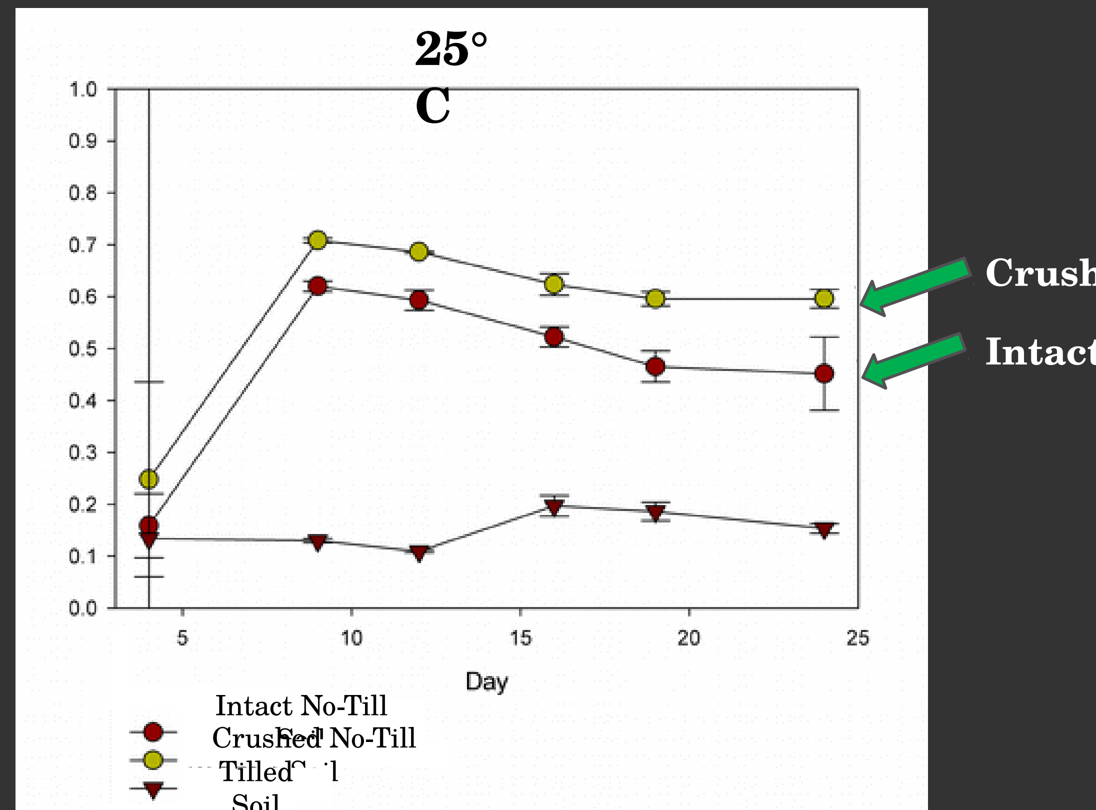
Cumulative Respiration



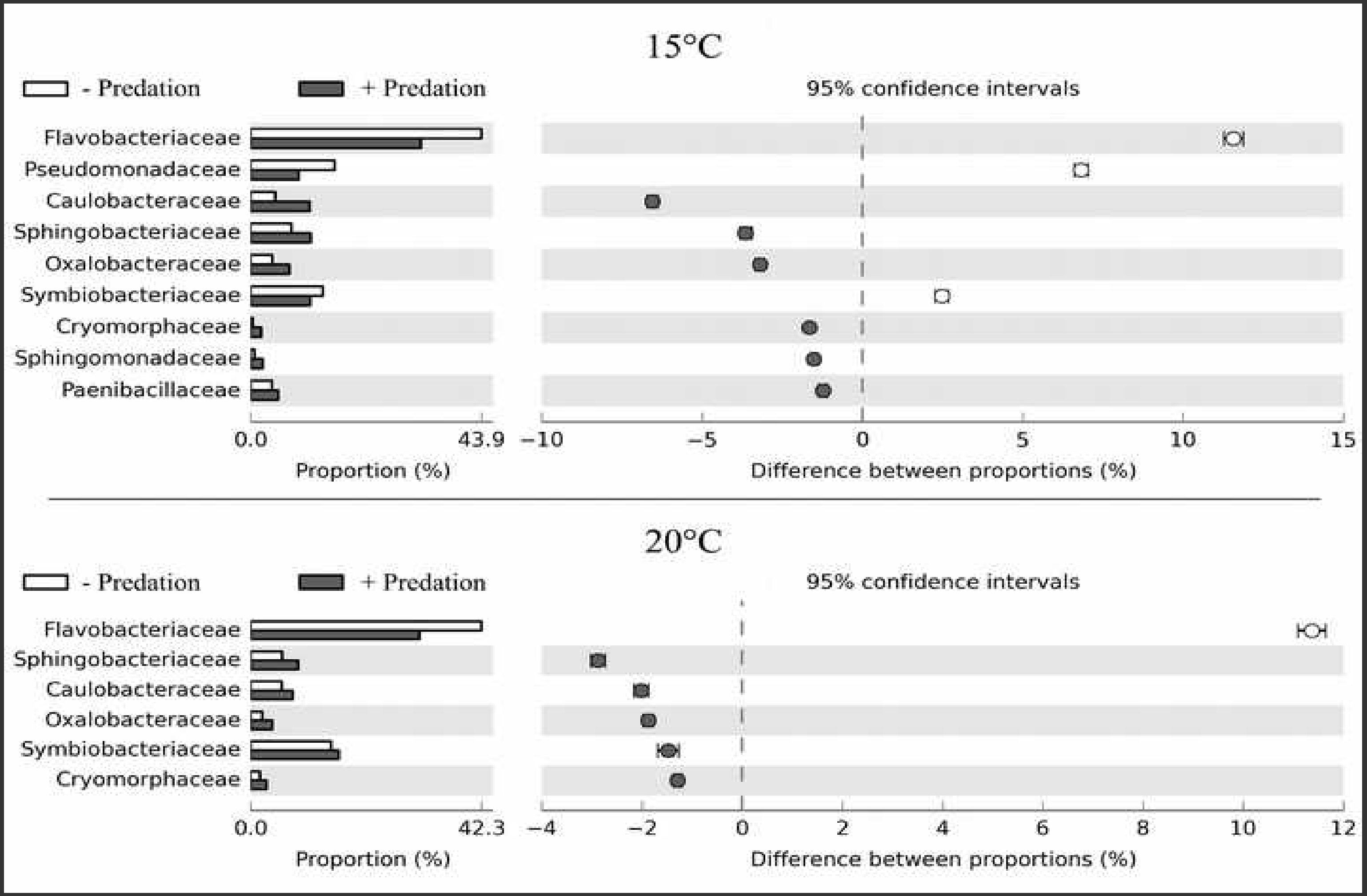
Cumulative respiration over time (µg CO2-C • g-1 dry soil). For "Community:" A=Amoebae and Bacteria; B=Bacteria Only; N=Natural control.
Note Y-axis scale in Till Soil treatments. Error bars represent 95% C.I. for the mean.

Proportion of respiration attributable to predation





Effects of predation at both temperatures



Significant changes (p<0.05, Fisher's exact test – FDR adjusted) with effect size > 2%

Conclusion:

Warming soil increases bacterial respiration. . .

But it does it primarily by changing protist predation pressures!