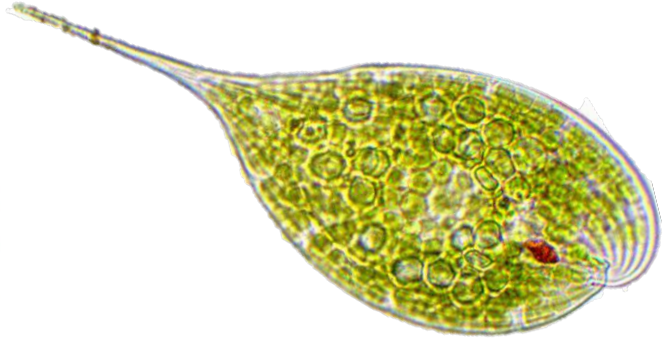
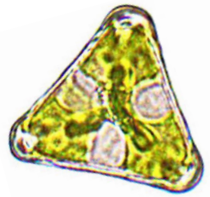
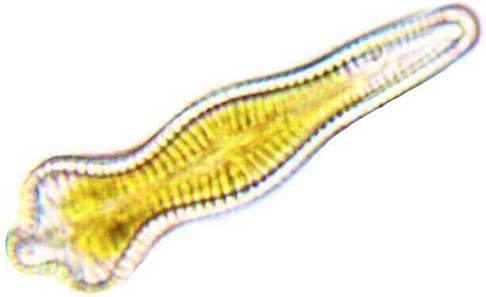
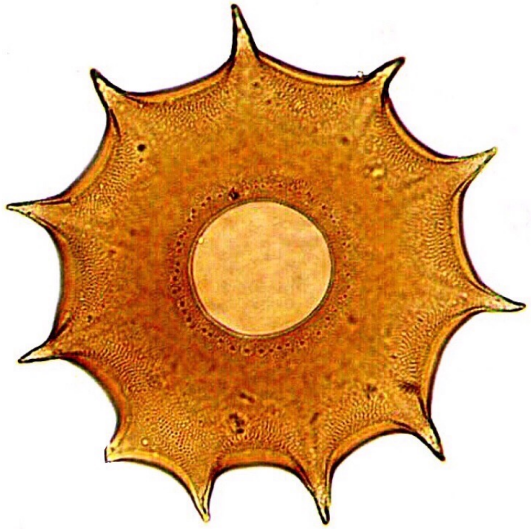
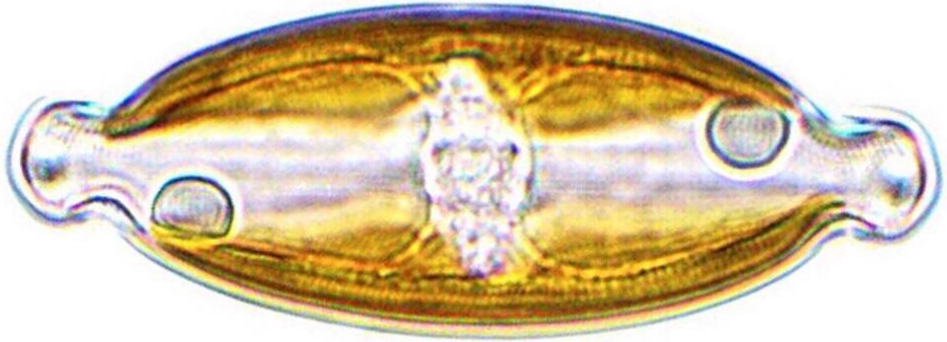



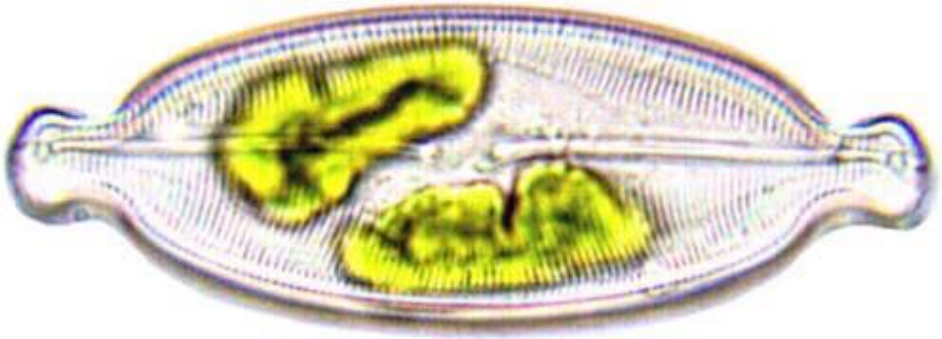



Protists

AN INTRODUCTION

Julia Van Etten



What is a microbe?

“A microscopic organism, which may exist in its single-celled form or in a colony of cells” -Wikipedia

vs.

“A microbe, or “microscopic organism,” is a living thing that is too small to be seen with the naked eye.” –Genetic Science Learning Center

To microscopists, microbes typically include both prokaryotes and eukaryotes and both uni- and multicellular organisms

This is the definition that will be used in this lab exercise

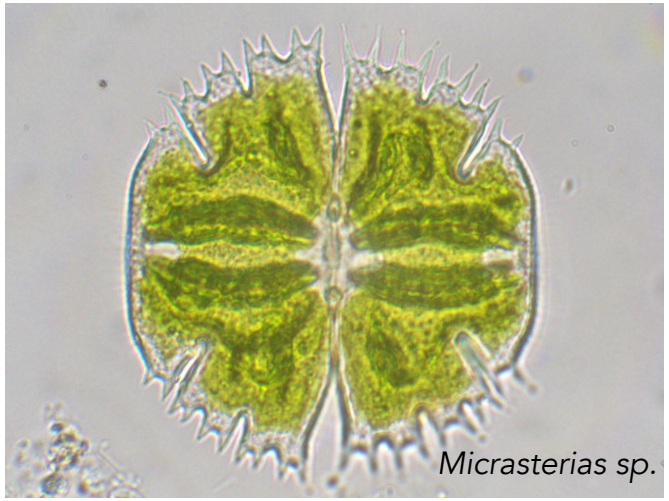
Microbial eukaryotes

Animals

Fungi

Algae

Red
Green
Glaucophyte



Non-algae protists

What is a protist and why are they important?

What they aren't:

"A protist is any eukaryotic organism that is not an animal, plant or fungus. The protists do not form a natural group, or clade, since they exclude certain eukaryotes; but, like algae or invertebrates, they are often grouped together for convenience."-Wikipedia

→ Not a great definition…

What they are:

- Many kingdom-level phylogenetic groupings of organisms
- Some are primary producers (algae) that support ecosystems
- Photosynthetic protists are being used in biofuel research
- ~50% of photosynthesis on Earth is done by algae*
- Many are phagocytic (models for endosymbiosis)
- Many take part in symbiotic associations (dinoflagellates + coral)
- Some are pathogens (potato famine, African sleeping sickness, malaria)
- Some cause environmental concern like HABs (e.g. red tide)

→ A better characterization

Protists are VASTLY understudied…

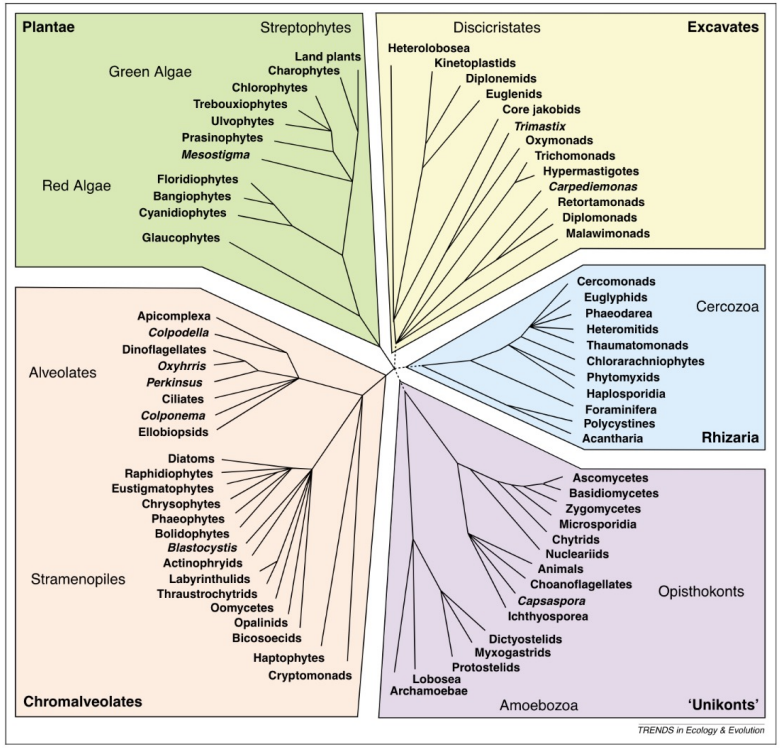
- Discovery-based vs. **hypothesis-driven** research is sometimes needed to make diversity estimates and ID new species
- Many are found in low numbers and obscure locations ("**rare biosphere**")
- Many are hard to culture
  - Some have only been discovered via 18S **metagenomic sequencing** and studied via **single cell genomics** (SCG)
    - Cell sorting (FACS) can be used to catalog protists for SCG sequencing
    - Microscopy can be used to catalog them on a much smaller scale (that's what we will be doing today)

See sources: 1, 2, 3

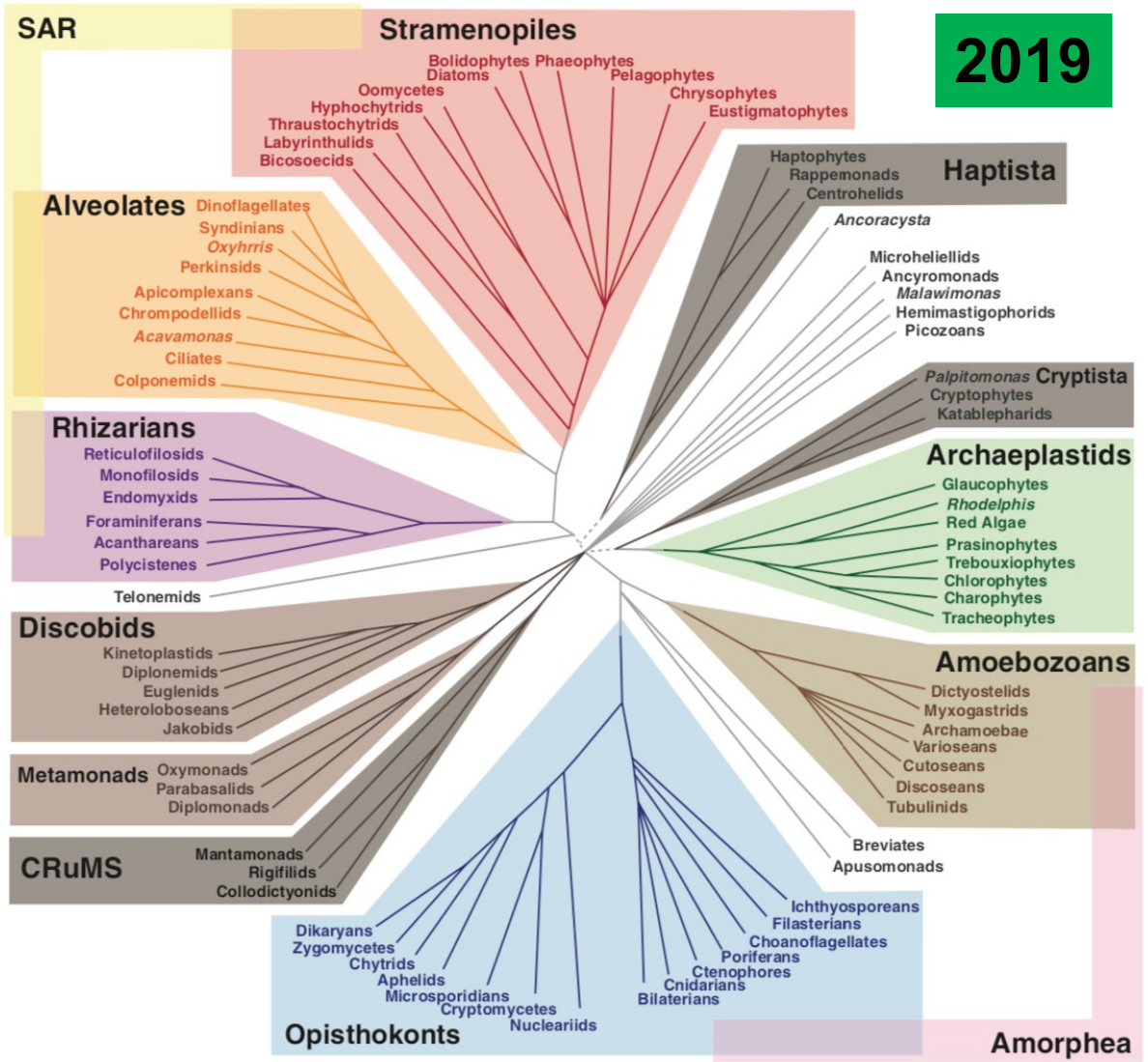
…which makes classification difficult

With more sequences available from more organisms, trees can be resolved with greater accuracy.

2005 **vs.** **2019**



Keeling et al. 2005



Keeling & Burki. 2019 Current Biology

See sources: 4, 5, 6

Protists were the first eukaryotes

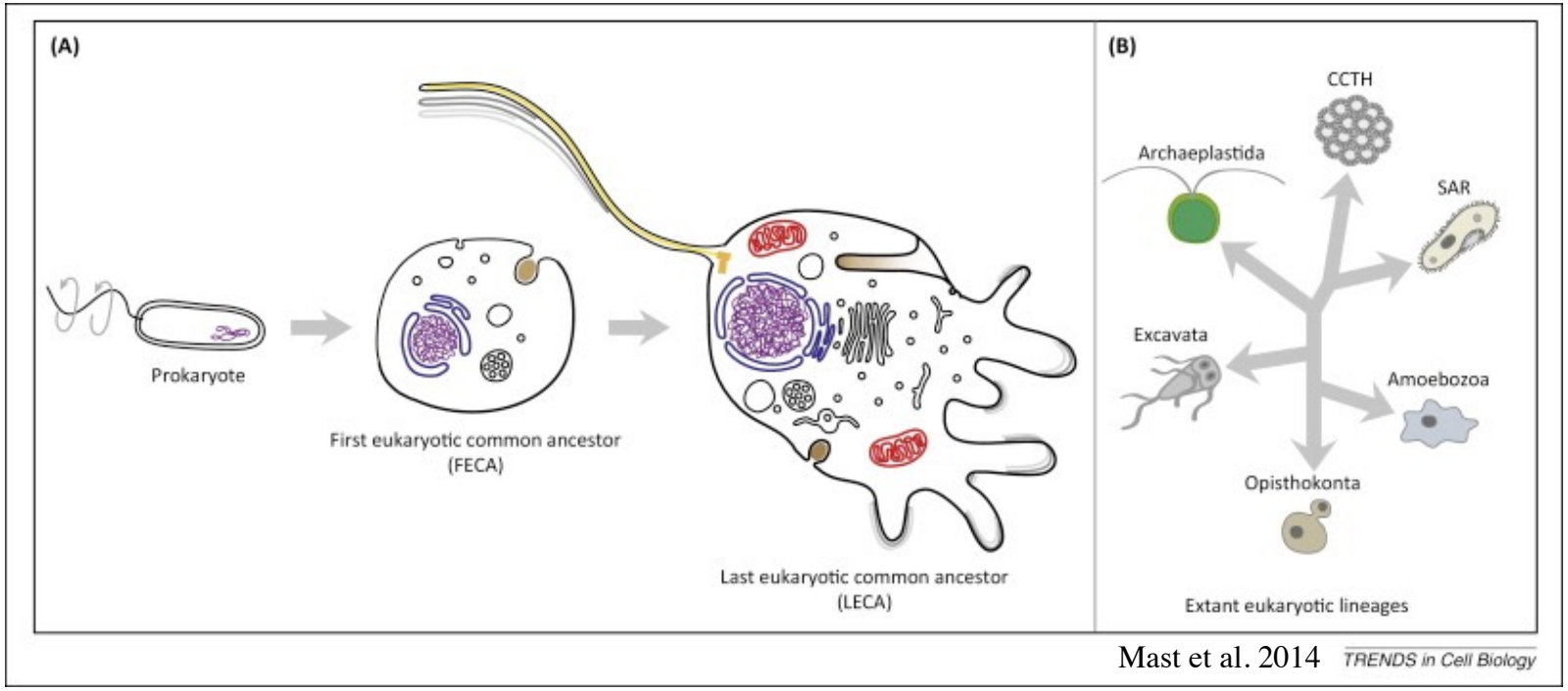
Primitive eukaryotic-like **archaeal** cell engulfs **alphaproteobacterium**

→

Endosymbiotic gene transfer
+
Symbiont genome reduction
+
Horizontal gene transfer

→

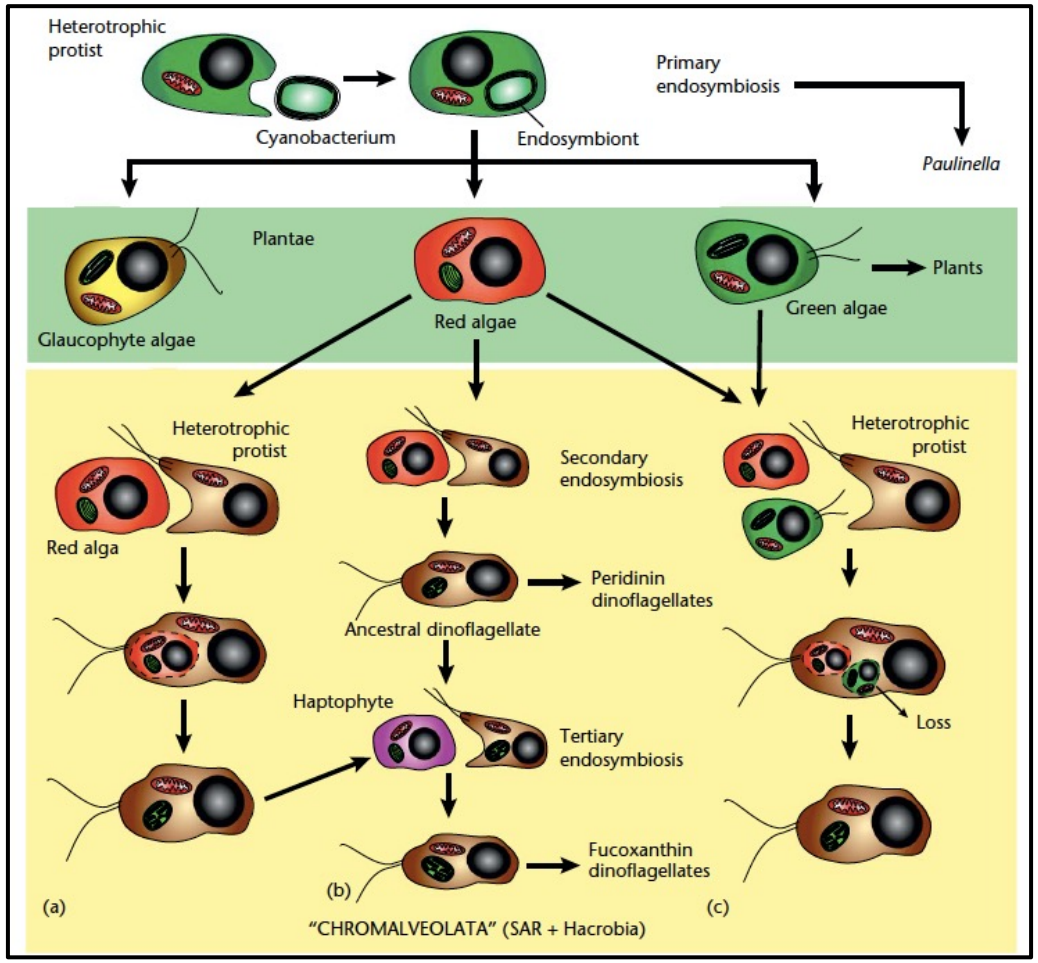
Eukaryote
FECA→LECA



See source: 7

Endosymbiosis: a common theme in protist evolution

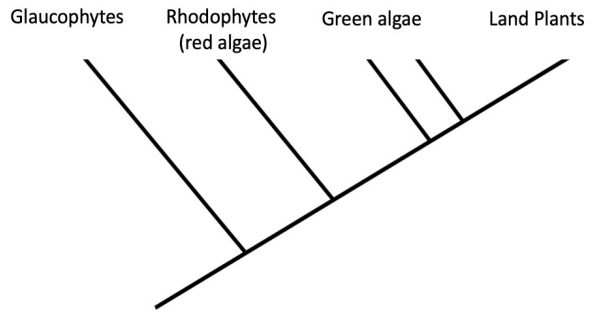
- Primary endosymbiotic events gave rise to eukaryotes + **mitochondria**
  - ca. ~2 bya
- And **chloroplasts**, which led to the evolution of Archaeplastida (algae + plants)
  - ca. >1 bya
  - Also, *Paulinella chromatophora* ~100mya
- Secondary and tertiary endosymbiotic gave rise to other photosynthetic protists
  e.g. euglenids, dinoflagellates + others →→→



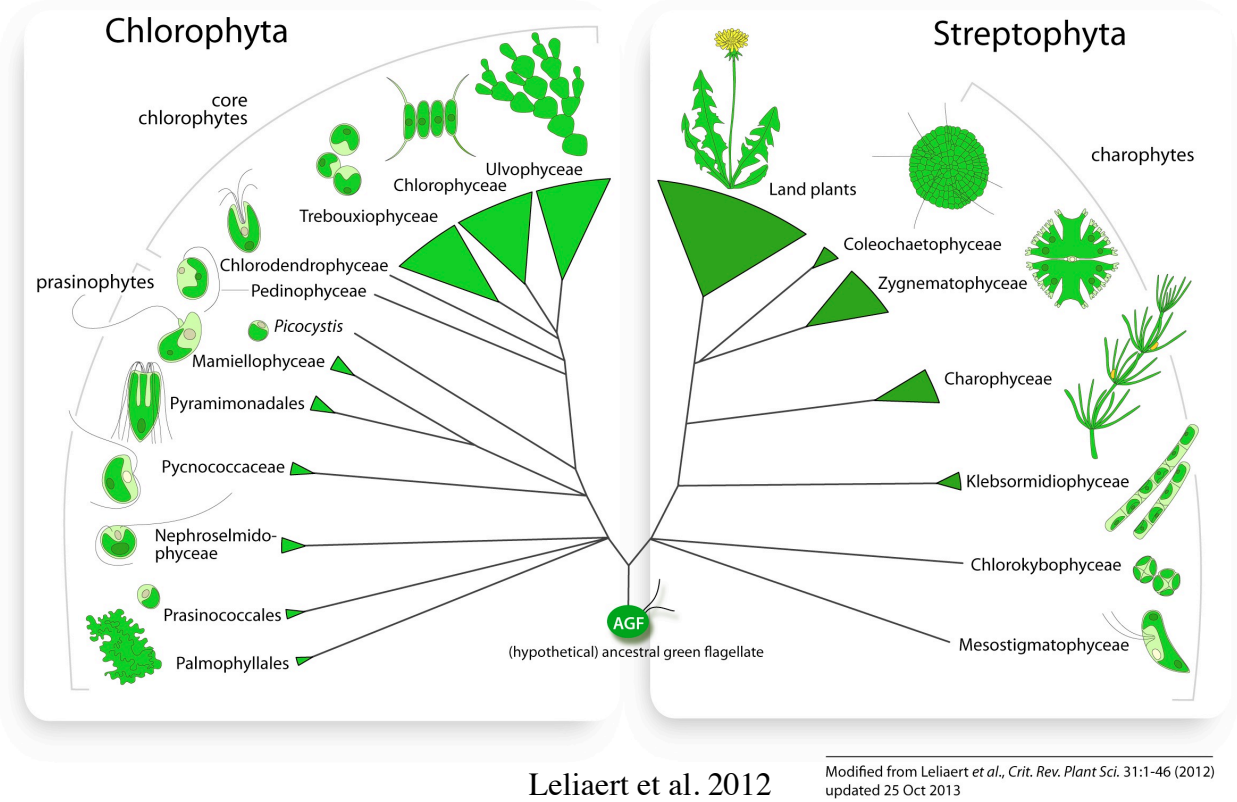
Chan & Bhattacharya 2011

See source: 8

(optional slide) Algae and Plants



- Archaeplastida is a eukaryotic sub-domain that includes algae (glaucophyte, red, green) and land plants
  - Archaeplastida arose when primary endosymbiosis led to chloroplasts (i.e. primary plastids)
- Land plants evolved from within the streptophyte lineage of green algae
- Metazoan (animal) and fungal clades also arose from within ancestral protistan lineages (see refs and next slide)



Leliaert et al. 2012

Modified from Leliaert *et al., Crit. Rev. Plant Sci.* 31:1-46 (2012)
updated 25 Oct 2013

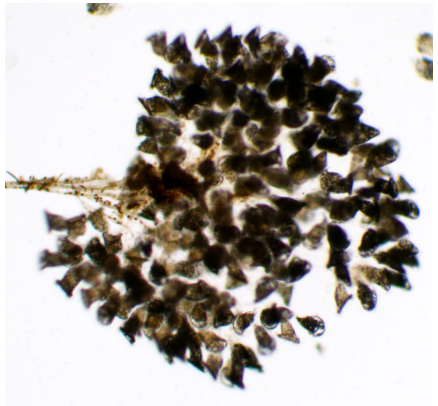
See sources: 9, 10, 11

Multicellularity

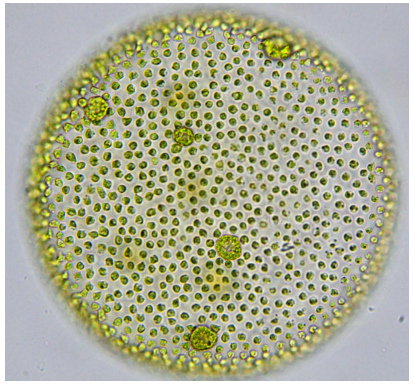
- Multicellularity has evolved at least dozens of times in eukaryotes
- **Complex** multicellular life has evolved less frequently (6x) in animals, land plants, red algae, brown algae, and fungi
  - E.g. Choanoflagellates as the sister to metazoans
- It is easy to observe colonial behavior in extant protists

You may witness this in the lab today!

  - Living in a colony and working together to survive, feed, and ultimately reproduce can be evolutionarily advantageous

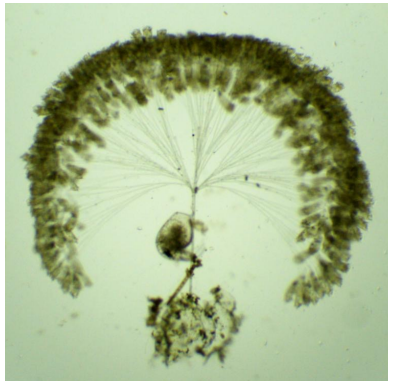


Campanella sp.

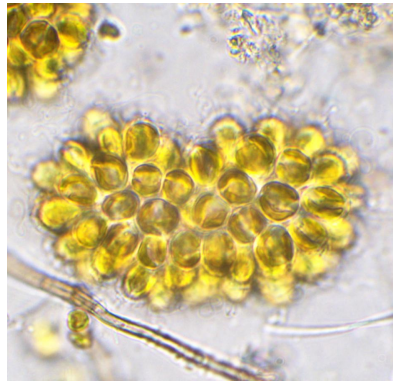


Volvox sp.

Choanoflagellates attached to star-shaped colony of diatoms (*Asterionella*)



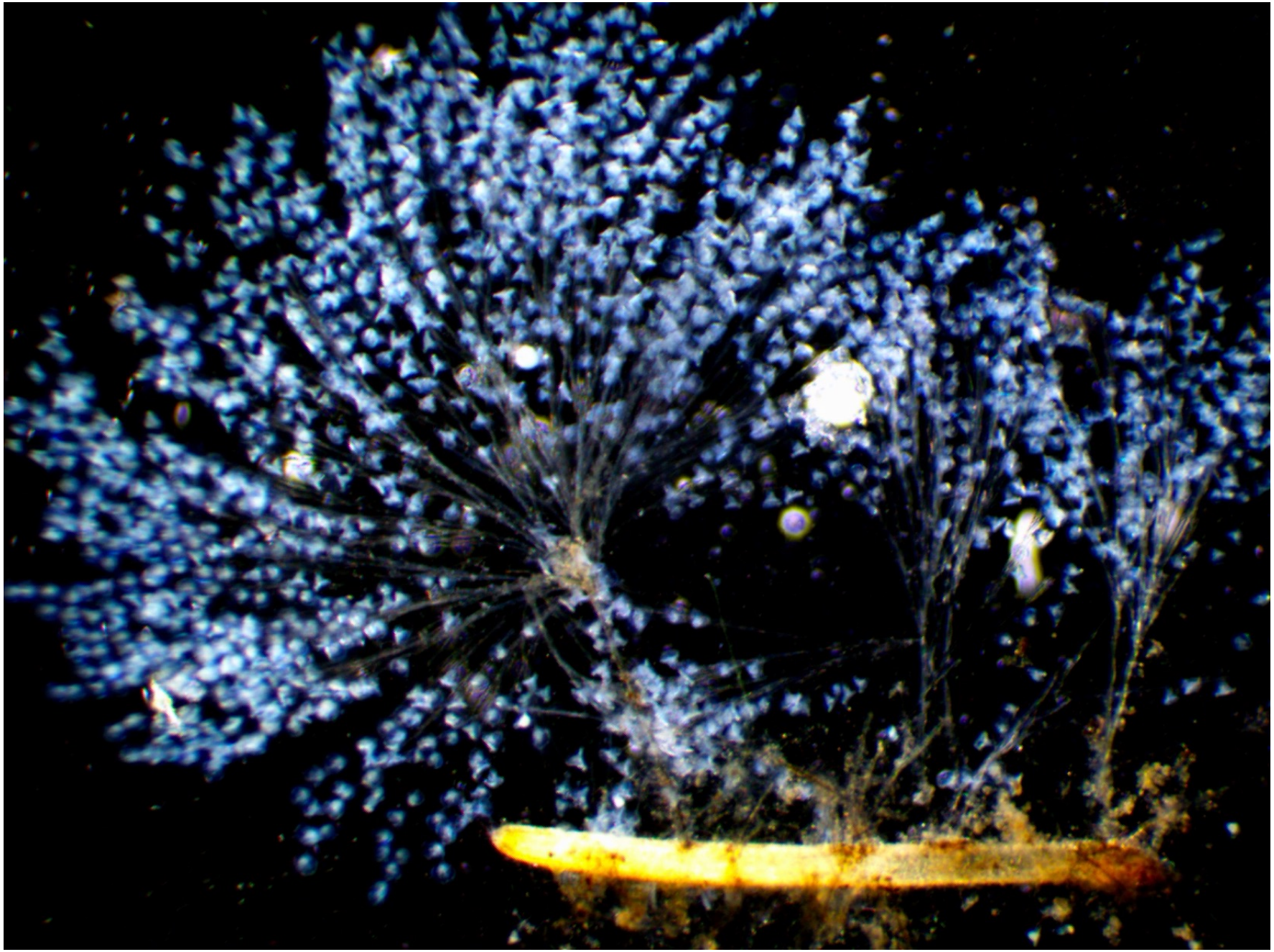
Zoothamnium sp.



Synura sp.

See sources: 12, 13, 14

<Video>
Link



Protist Ecology

- Somewhat **ubiquitous**
  -Found in mesophilic (most) to extreme environments (e.g., *Galdieria* sp., ice algae, etc.)
  -Freshwater, marine, soil, hot springs/acid mining sites, deep sea/vents
- **Metabolism and lifestyle**: photoautotrophy, mixotrophy, heterotrophy
- **Motility**: some motile, some non-motile
  -Cilia, flagella, pseudopodia, spasmoneme, mucus secretions, taxis, epibiotic
- **Reproduction**: can be sexual, asexual, or both (via binary fission, conjugation, or both)
- **Ecology**: primary producers, consumers, saprophytes, detritovores, parasites, pathogens, symbionts, endosymbionts, epibionts

Vorticella sp. (peritrich ciliates) living as epibionts on a juvenile freshwater snail

Citations (in the order they appeared in the presentation)

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