

# Diversity of phytoplankton and implications for the use of fluorescence of photosynthetic pigments as biomass proxies

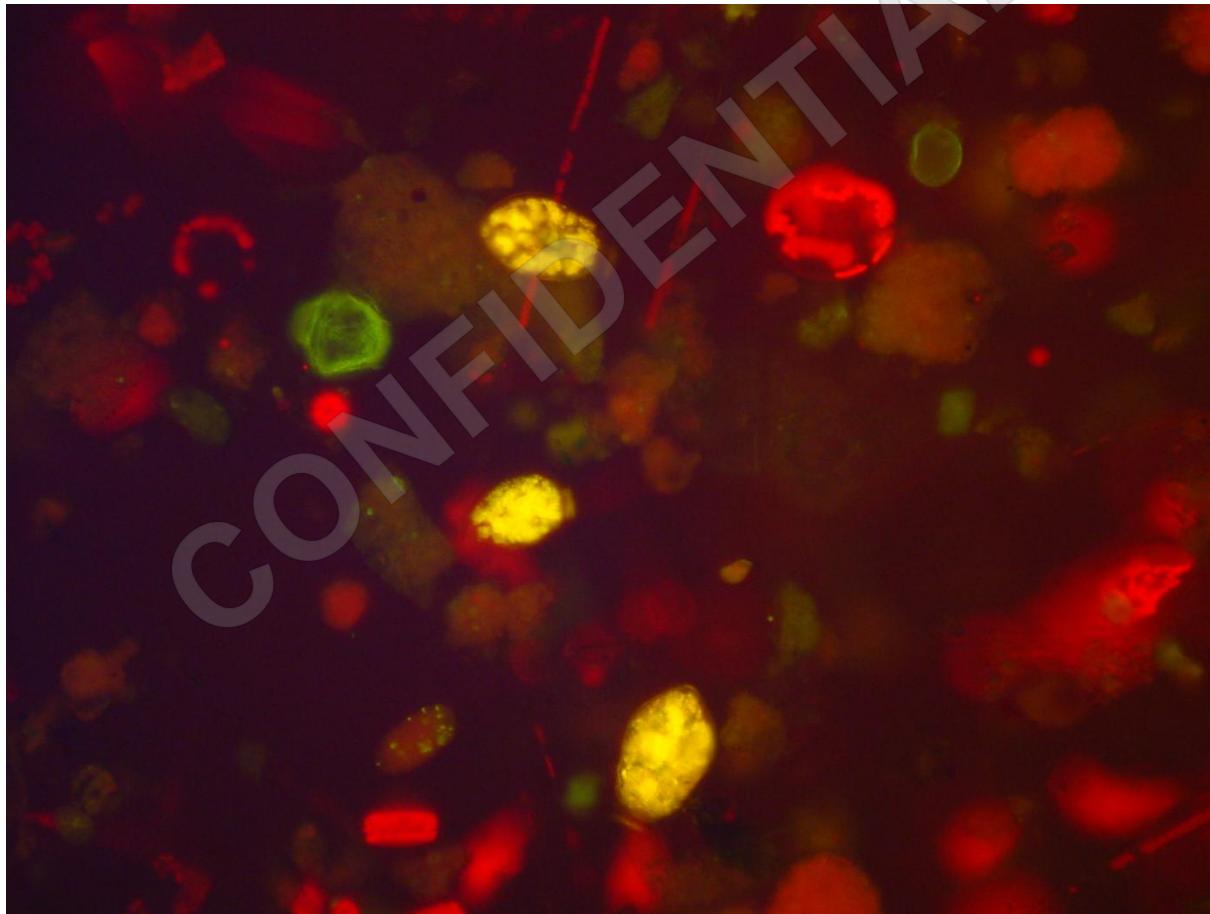
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Photo Helena Höglander, source <http://nordicmicroalgae.org>

# What is absorbing, fluorescing and scattering light in seawater?



# Some phytoplankton species in the Baltic and the Kattegat-Skagerrak

Number of described species is in the order of 2000

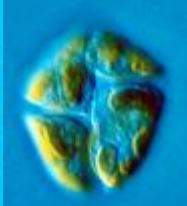
Photos: Bengt Karlson,  
Ann-Turi Skjekvik, Lars  
Edler, Jahn Thronsdæn  
and Wenche Eikrem



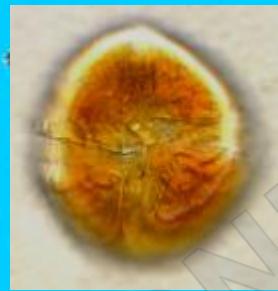
*Dinophysis* spp.



*Synechococcus* sp.



*Karenia mikimotoi*

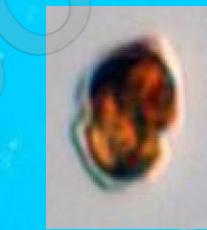


*Alexandrium tamarensense*



cf. *Azadinium spinosum*

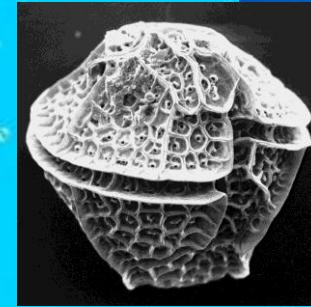
May-Oct  
Max 10 000 cells l<sup>-1</sup>



*Nodularia spumigena*



*Ceratium tripos*



*Protoceratium reticulatum*



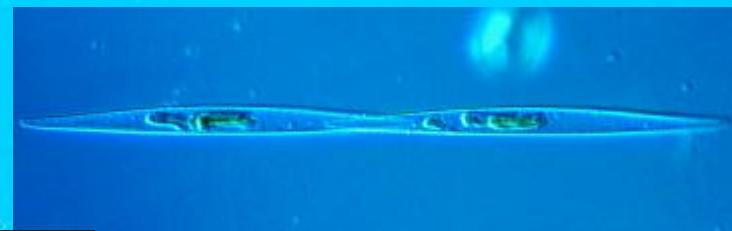
*Chrysochromulina polylepis*



Photo: Ann-Turi Skjekvik



*Pseudochattonella farcimen*

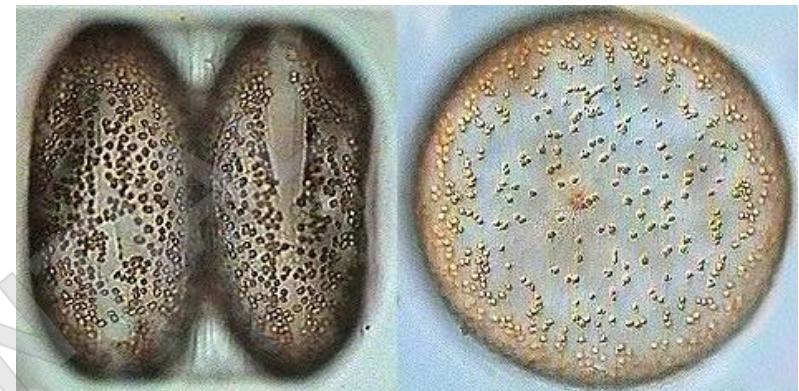


*Pseudo-nitzschia* sp.

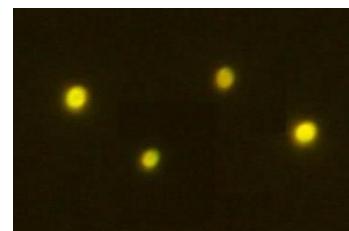
*Chaetoceros concavicornis*



# Size range 1-1000 µm



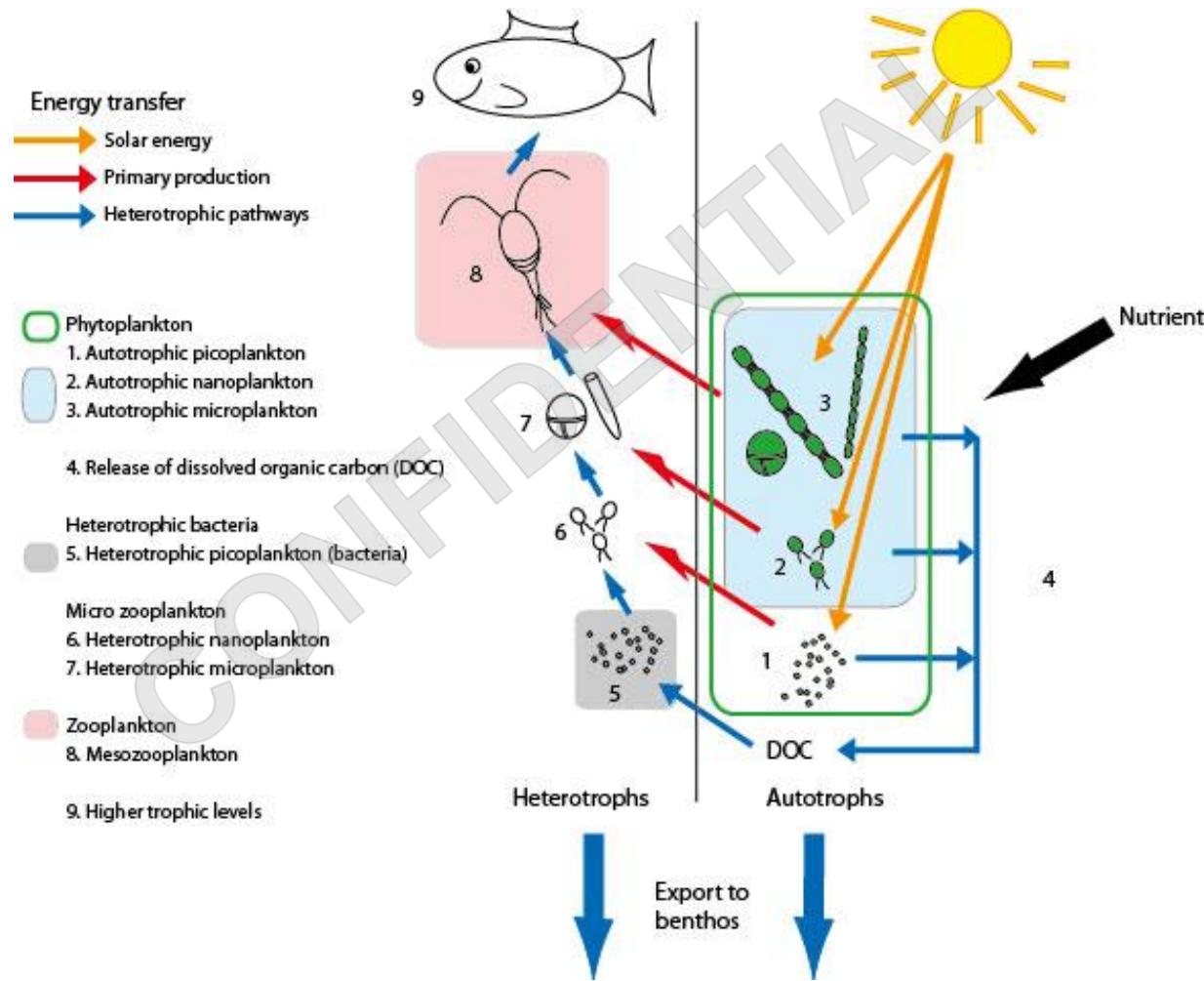
Large diatom, *Coscinodiscus concinnus*



Plankton photo by Mats Kuylensstierna

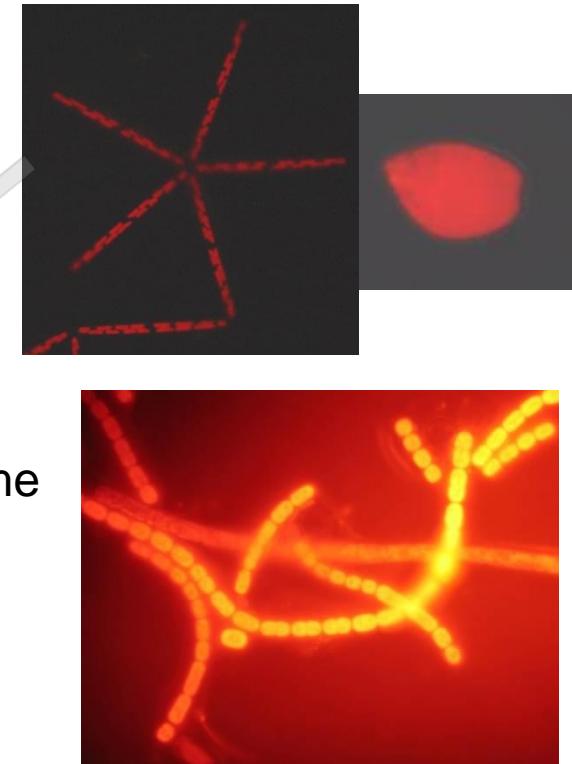
Small cyanobacteria, *Synechococcus* sp.

# The classic food web and the microbial loop



# Pigments we are trying to detect using fluorescence

- Chlorophyll a – found in all phytoplankton except for *Prochlorococcus*
- *Phycocyanin* – found in some cyanobacteria but also in some cryptophytes
- *Phycoerythrin* – found in some cyanobacteria and in some cryptophytes, dinoflagellates and a ciliate



Photos by Bengt Karlson and Kevin Vikström

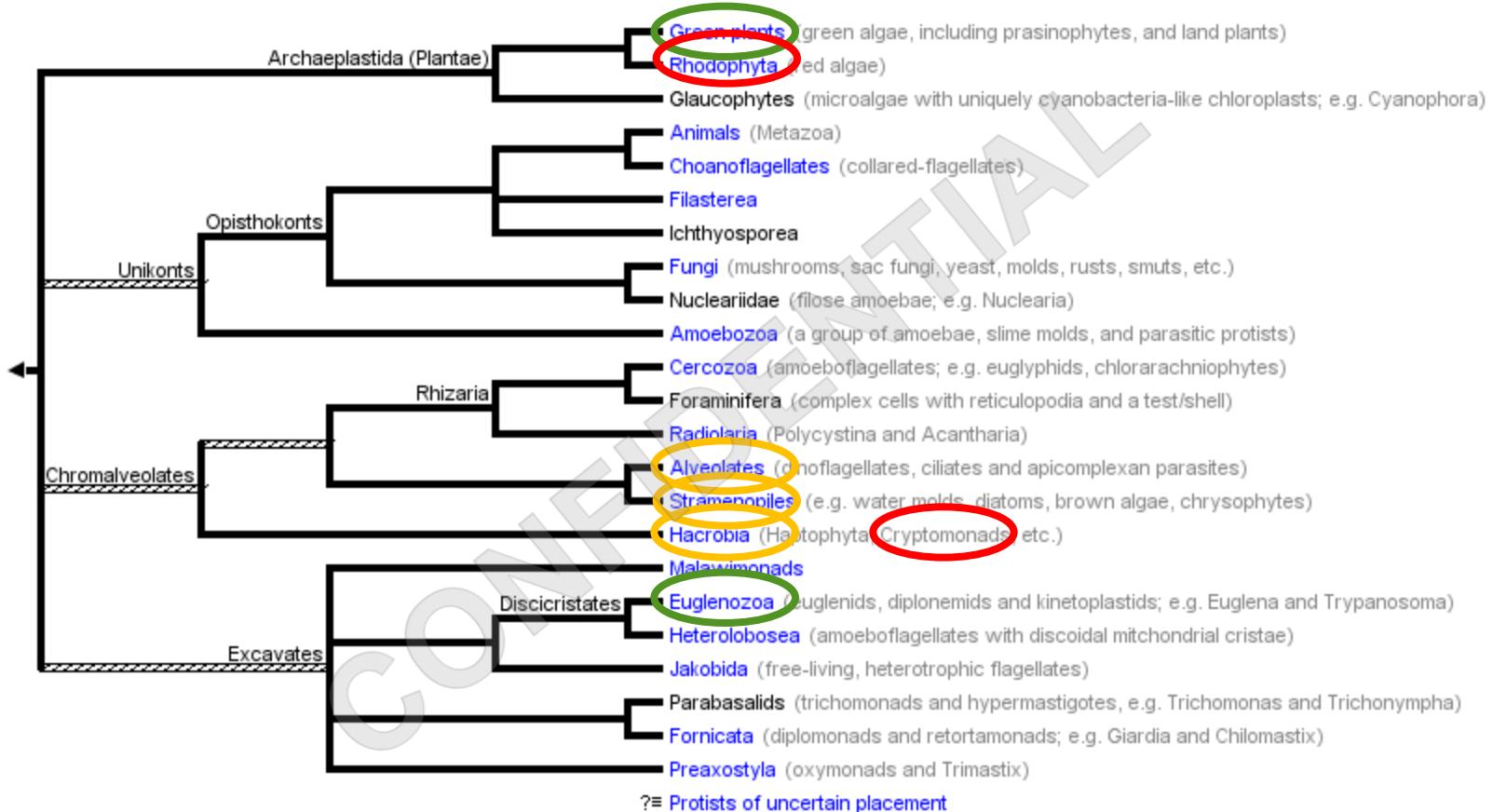
# Tree of life <http://tolweb.org>



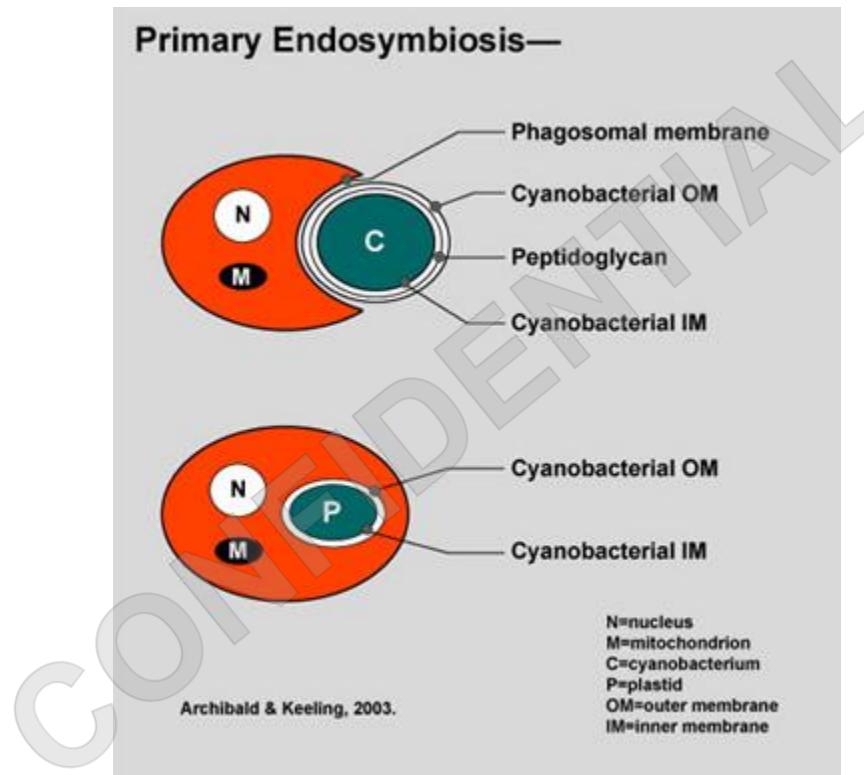
# Cyanobacteria

- Aquifaceae (hyperthermophilic chemolithoautotrophs)
- Thermotogae (hyperthermophilic, obligately anaerobic, fermentative heterotrophs)
- Thermodesulfobacteria (thermophilic, sulfate-reducing bacteria)
- Chrysiogenetes (a chemolithoautotrophic bacterium)
- Nitrospira (includes nitrite-oxidizers, thermophilic sulfate reducers, and acidophilic iron oxidizers)
- Deferribacteres (a group of aquatic, anaerobic bacteria)
- Chloroflexi (green nonsulfur bacteria)
- Thermomicrobia (hyperthermophilic chemoheterotrophs)
- Fibrobacteres (cellulose digesting, anaerobic rumen bacteria)
- Proteobacteria (purple bacteria and relatives)
- Planctomycetes (bacteria with peptidoglycan-less cell walls and budding reproduction)
- Chlamydiae (obligate intracellular parasites of eukaryotic cells)
- Spirochaetes (spiral-shaped chemoheterotrophs)
- Bacteroidetes (a diverse group including pathogens, commensals, and free-living bacteria)
- Chlorobi (green sulfur bacteria)
- Actinobacteria (high G+C Gram positives)
- Deinococcus-Thermus (a group of extremophiles)
- Cyanobacteria** (oxygenic photosynthetic bacteria and chloroplasts)
- Firmicutes (low G+C Gram positives)
- Fusobacteria (anaerobic heterotrophs, many involved in human infections)
- Verrucomicrobia (terrestrial, aquatic, some associated with eukaryotic hosts)
- Acidobacteria (acidophilic bacteria common in soils)
- Dictyoglomi (thermophilic chemoorganotrophs)
- Gemmatimonadetes (Gram-negative bacteria lacking DAP in their cell envelopes)

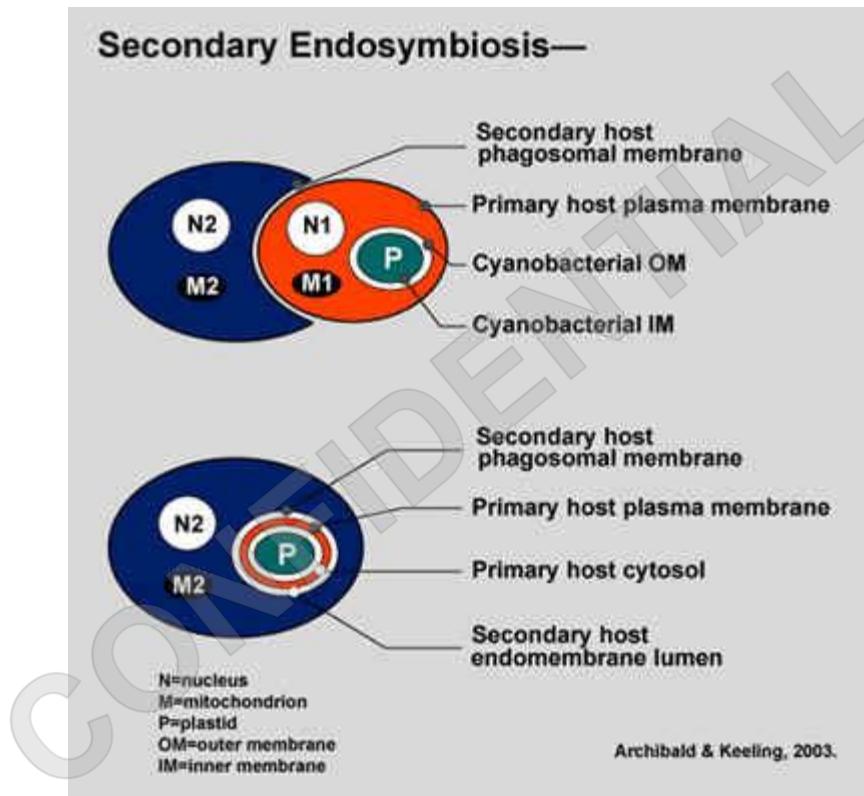
# Eukaryotic algae



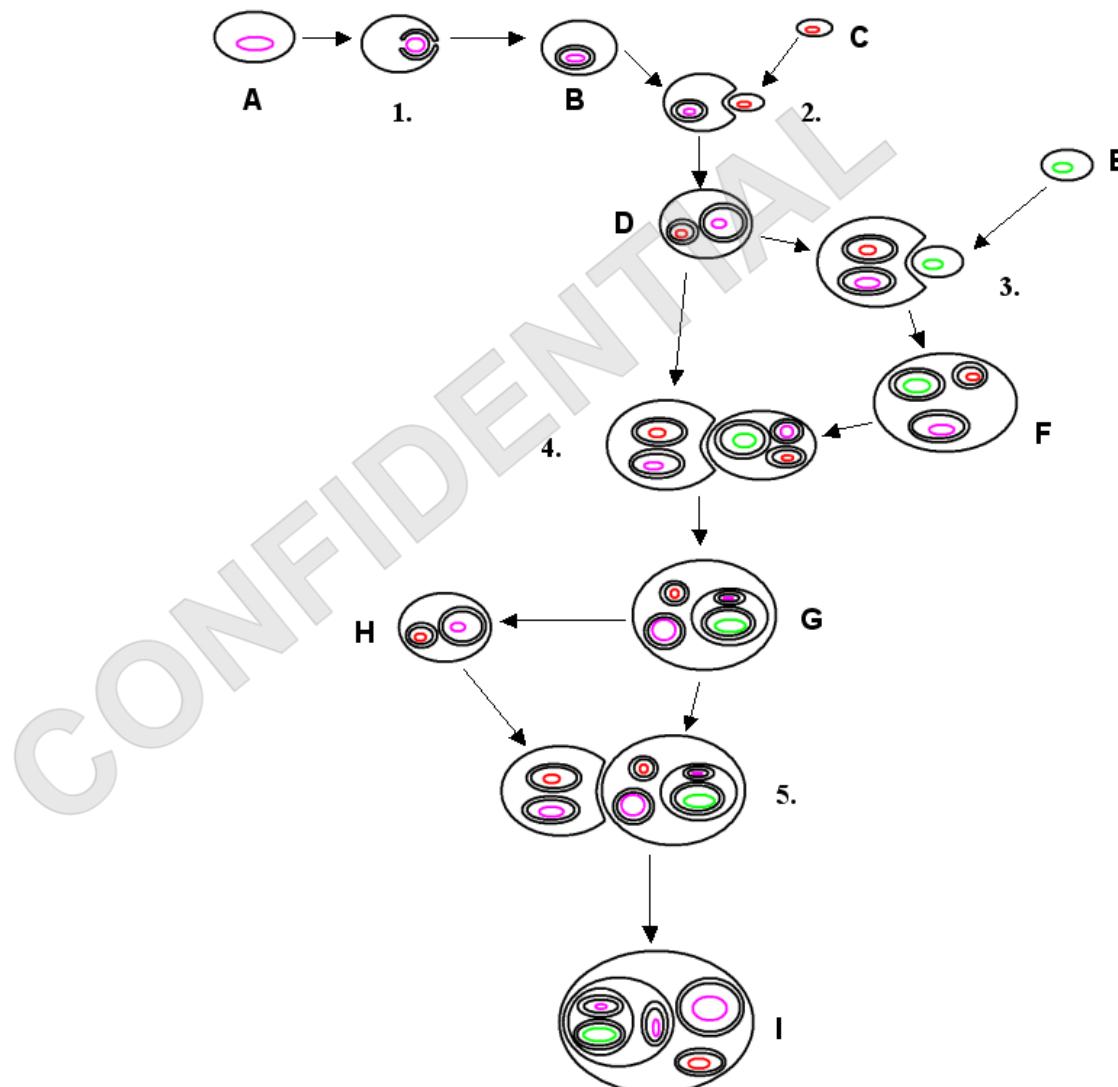
# Primary endosymbiosis



# Secondary endosymbiosis



# Stealing power plants and genes is common



# Does it matter for ocean optics? Yes!

*Karenia mikimotoi* -  
a dinoflagellate with diatom chloroplasts

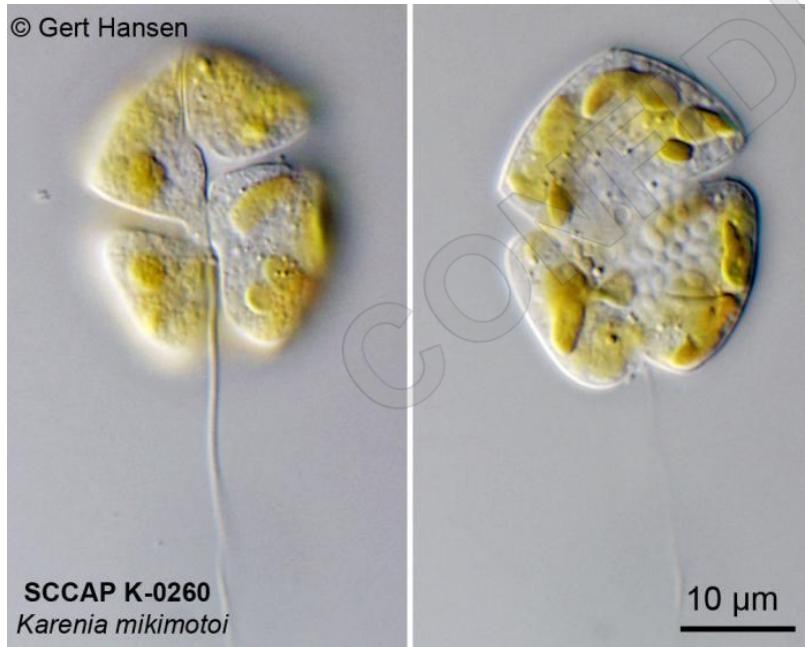


Photo Gert Hansen, source <http://nordicmicroalgae.org>

*Dinophysis acuta* -  
a dinoflagellate with cryptophyte  
chloroplasts

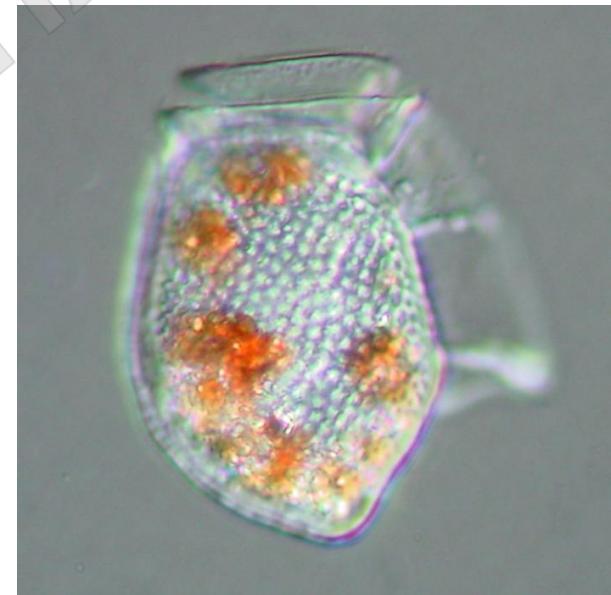


Photo Bengt Karlson, source  
<http://nordicmicroalgae.org>

# Coccolithophorids

*Emiliania huxleyi*  
is covered with calcium  
carbonate scales

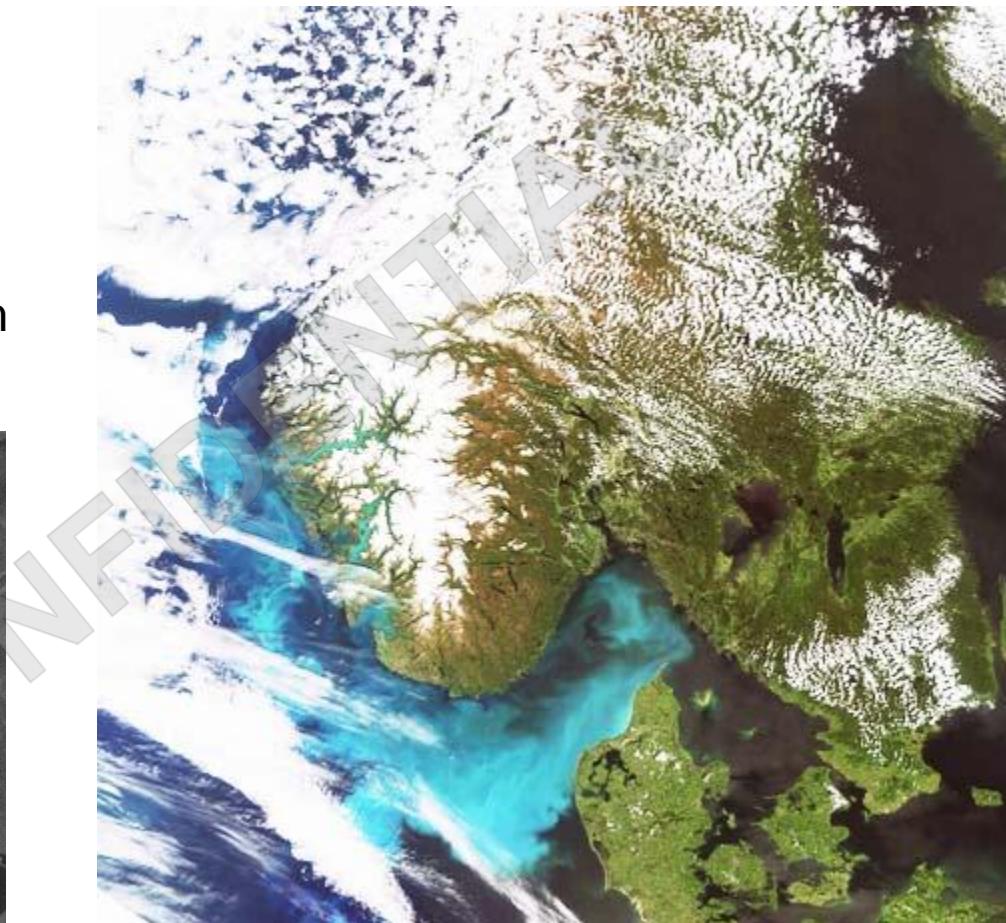
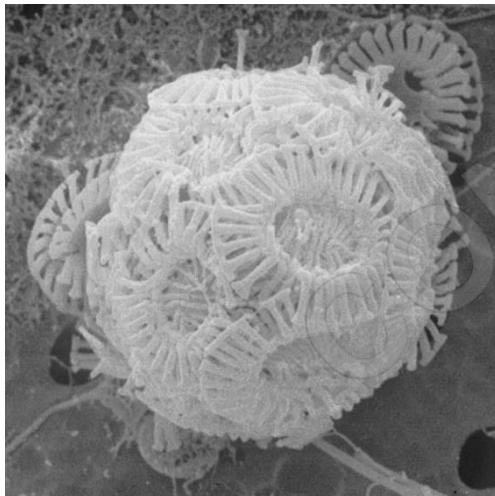


Photo Bengt Karlson, source  
<http://nordicmicroalgae.org>

# Cyanobacteria

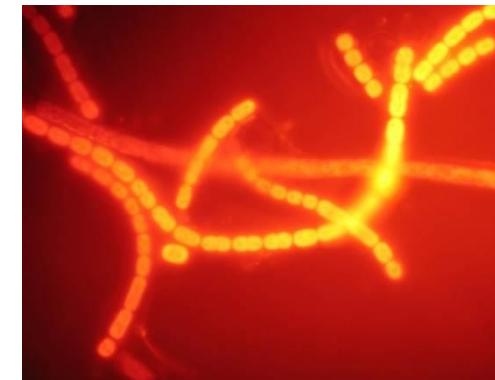
*Aphanizomenon* sp.



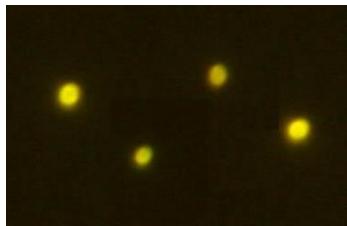
*Nodularia* spumigena



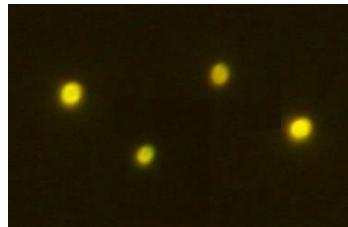
*Dolichospermum* sp.



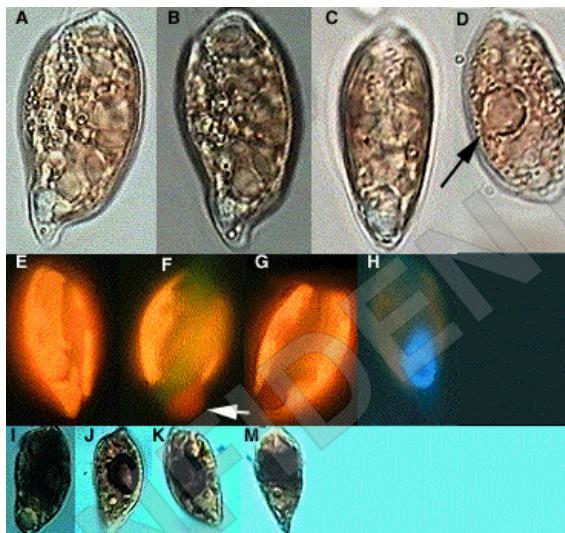
*Synechococcus* sp.



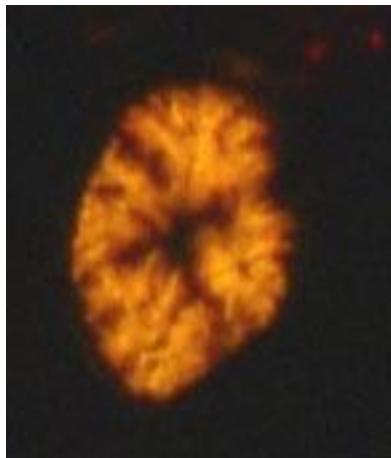
# Phycoerythrin rich plankton



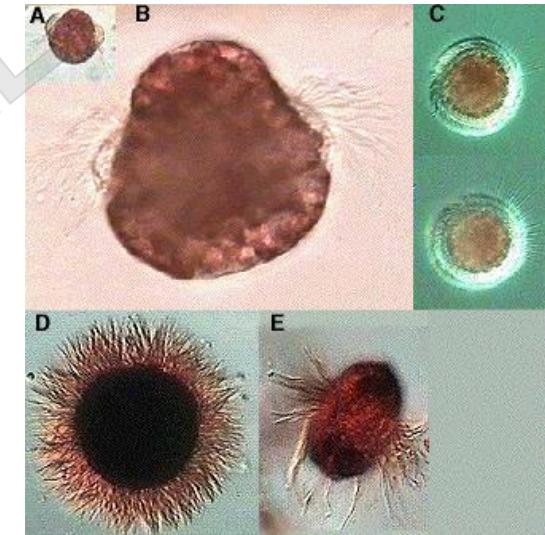
*Synechococcus* sp.



*Rhodomonas marina*

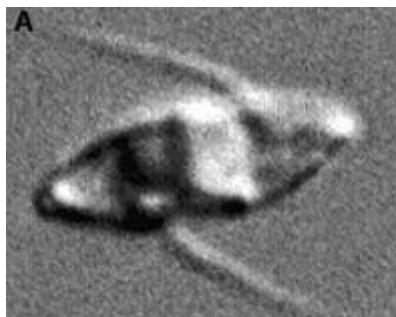


*Dinophysis* spp.

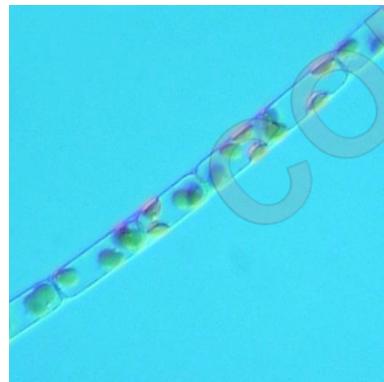


*Mesodinium rubrum* =  
*Myrionecta rubra*

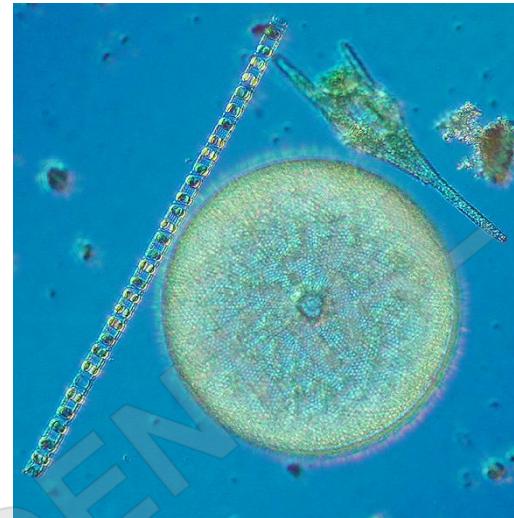
# Diatoms



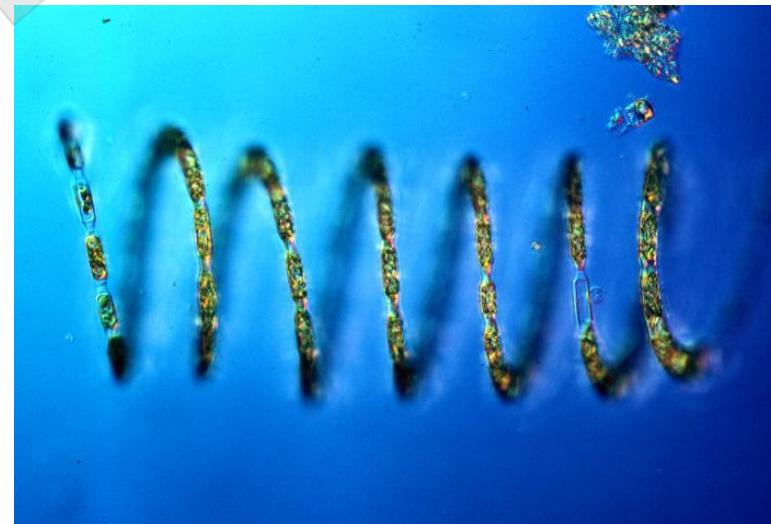
Solitary diatom,  
*Minutocellus polymorphus*



Chain forming diatom,  
*Leptocylindrus danicus*



Large diatom, *Coscinodiscus concinnus*



Chain forming diatom, *Eucampia zodiacus*

An aerial photograph of a large red cargo ship sailing from the bottom right towards the top left. The ship is surrounded by dark green, choppy ocean water. A prominent diagonal watermark reading "CONFIDENTIAL" is overlaid across the center of the image.

**Thank you for your attention**