10. Archaeplastida (Chloroplastida) pokračování

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Místnost 78, 2. mezipatro, Benátská 2

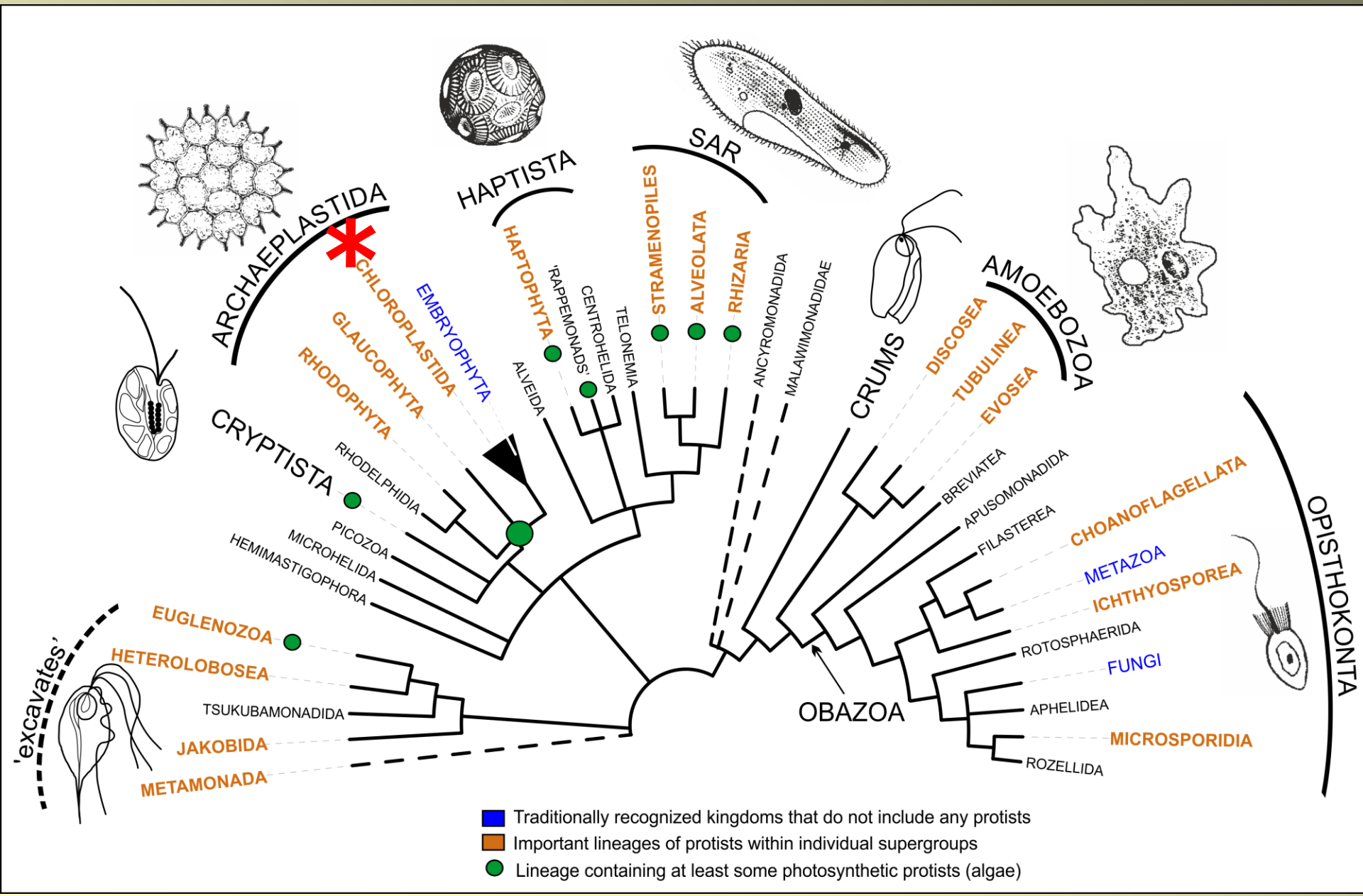
Botanika bezcévných rostlin a protistologie

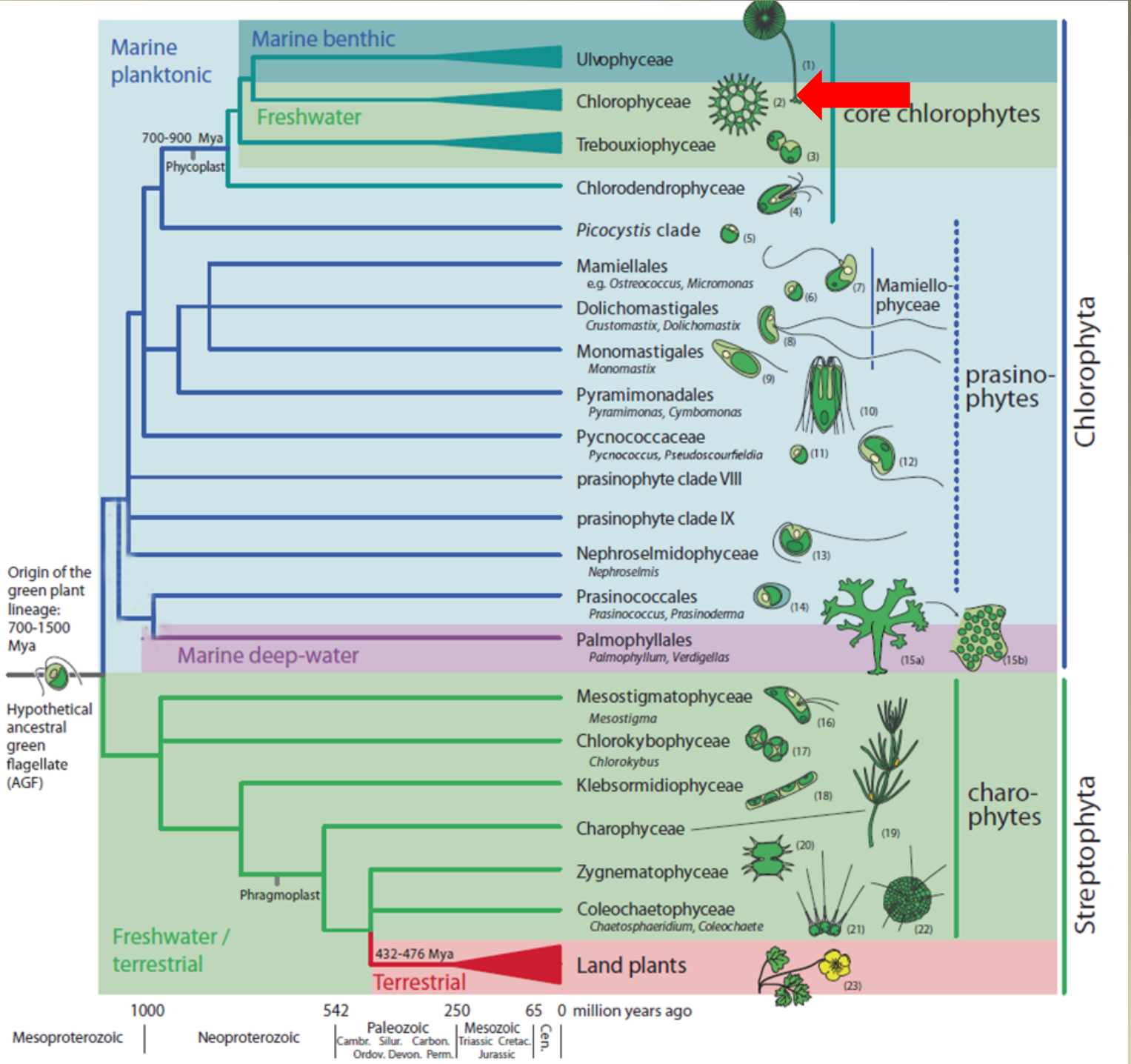
(MB120P76U)

Přednášky

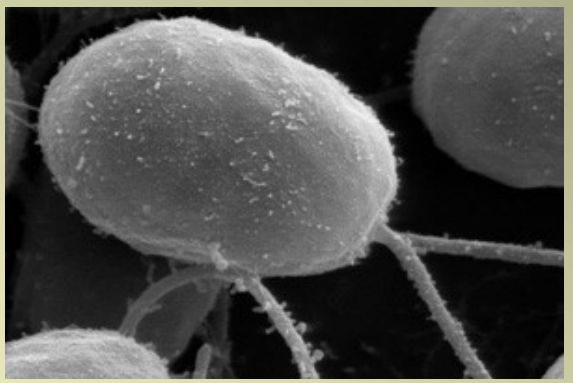
1) Eukaryotická buňka a její vznik … Tomáš Pánek
2) Systém eukaryot, Excavata … TP
3) Opisthokonta, Amoebozoa … TP
4) Pohyb, evoluce mnohobuněčnosti … TP,
5) Úvod do SAR a heterot. SAR … TP
6) Fototrofní SAR … Yvonne Němcová
7) Fototrofní Stramenopiles, Haptista, Cryptista … YN
8) Sinice + Archaeplastida (Glaucophyta, Rhodophyta) …YN
9) Archaeplastida (Chloroplastida) … YN
10) **Archaeplastida (Chloroplastida) pokračování … YN**
11) Mechorosty … David Svoboda
12) Mechorosty/lišejníky … DS
13) Lišejníky … DS

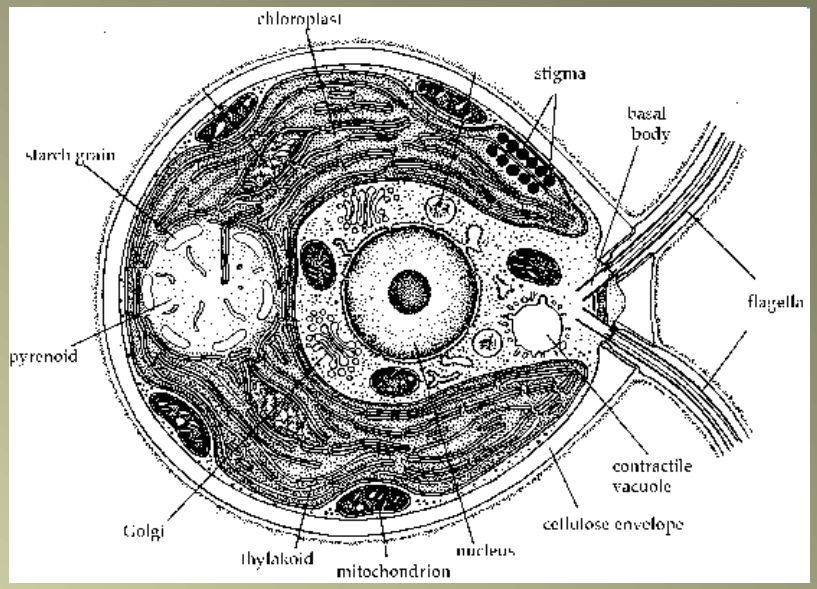
Archaeplastida: Chloroplastida



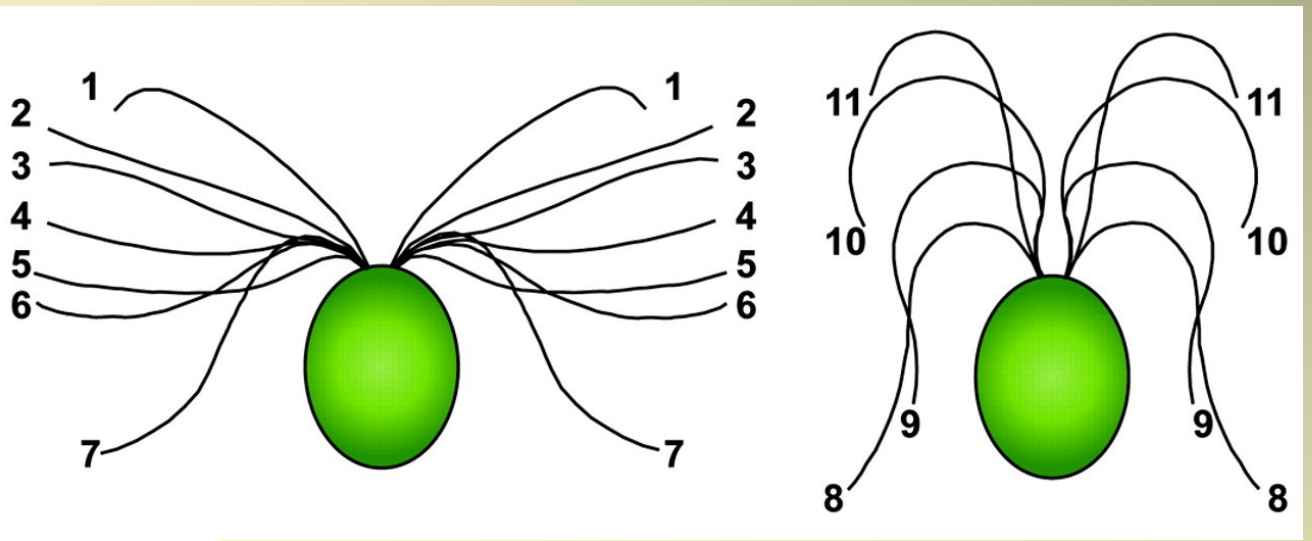

Marine planktonic
Marine benthic
Freshwater
Ulvophyceae
Chlorophyceae
Trebouxiophyceae
core chlorophytes
700-900 Mya
Phycoplast
Chlorodendrophyceae
Picocystis clade
Mamiellales
e.g. Ostreococcus, Micromonas
Dolichomastigales
Crustomastix, Dolichomastix
Monomastigales
Monomastix
Pyramimonadales
Pyramimonas, Cymbomonas
Pycnococcaceae
Pycnococcus, Pseudoscourfieldia
prasinophyte clade VIII
prasinophyte clade IX
Nephroselmidophyceae
Nephroselmis
Prasinococcales
Prasinococcus, Prasinoderma
Palmophyllales
Palmophyllum, Verdigellas
Mamiello-phyceae
prasino-phytes
Chlorophyta
Marine deep-water
Origin of the green plant lineage: 700-1500 Mya
Hypothetical ancestral green flagellate (AGF)
Mesostigmatophyceae
Mesostigma
Chlorokybophyceae
Chlorokybus
Klebsormidiophyceae
Charophyceae
Zygnematophyceae
Coleochaetophyceae
Chaetosphaeridium, Coleochaete
charo-phytes
Streptophyta
Phragmoplast
Freshwater / terrestrial
432-476 Mya
Terrestrial
Land plants
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(15a)
(15b)
(16)
(17)
(18)
(19)
(20)
(21)
(22)
(23)
1000
542
250
65
0 million years ago
Mesoproterozoic
Neoproterozoic
Paleozoic
Cambr. Silur. Carbon. Ordov. Devon. Perm.
Mesozoic
Triassic Cretac. Jurassic
Cen.

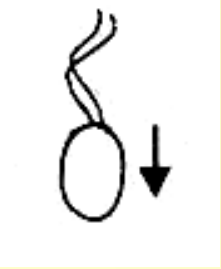
Třída: *Chlorophyceae*





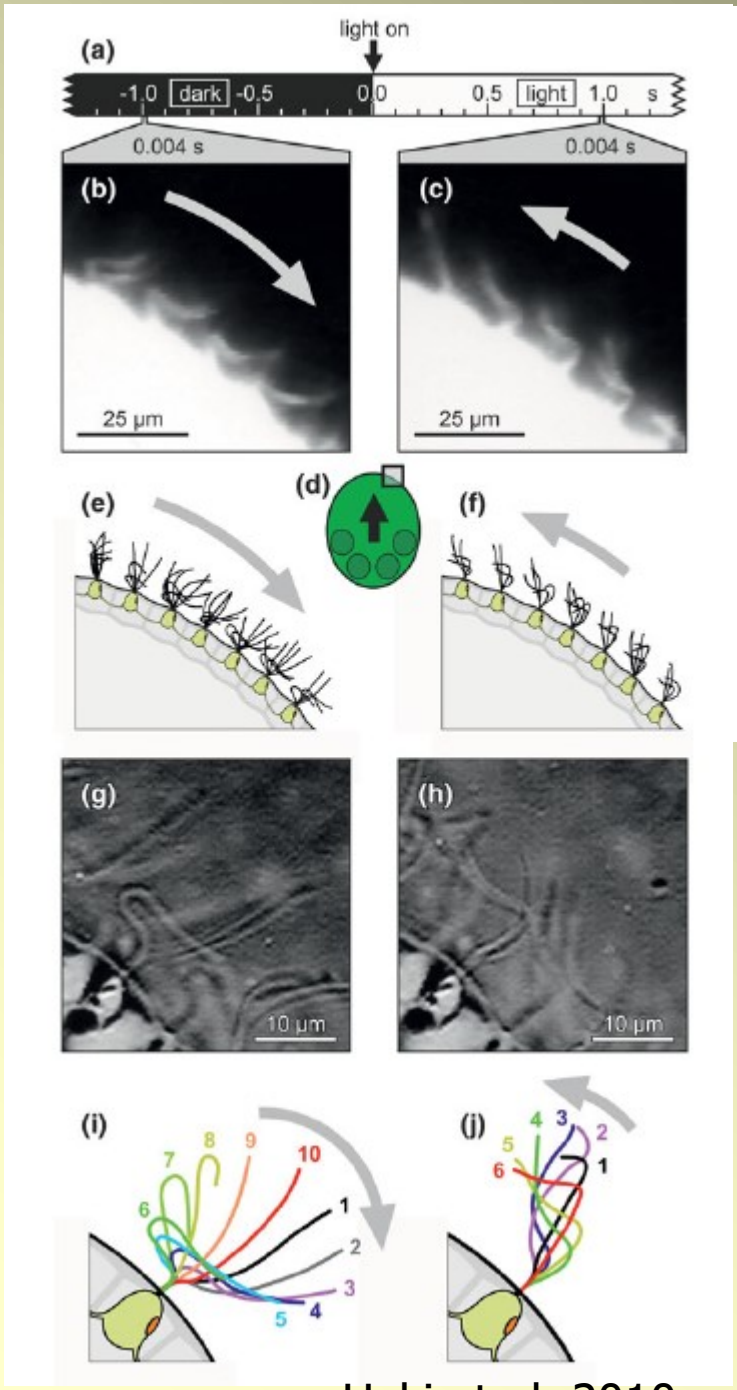
Jak plave *Chlamydomonas?*



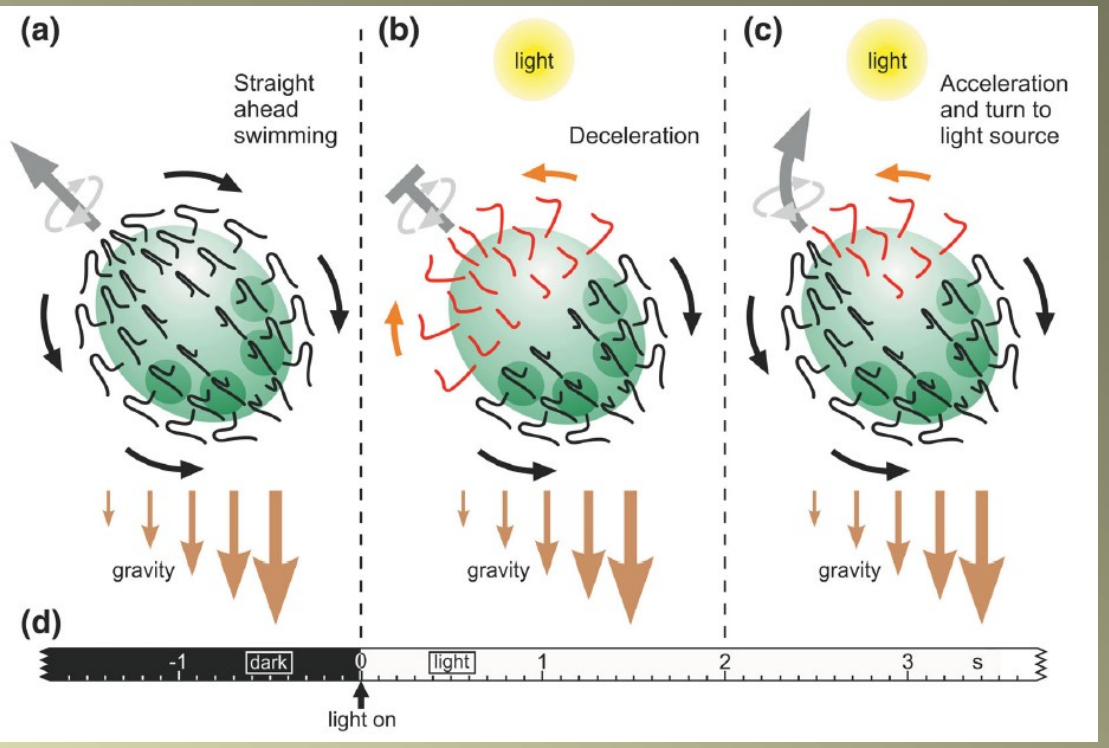


Chlamydomonas reinhardtii - modelový rostlinný bičíkovec

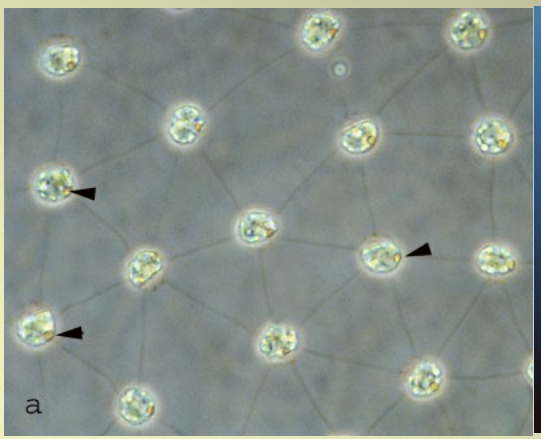
Jak se buňka pohybuje?
Jak rozeznají jedna druhou?
Jak reaguje na světlo?
Jak reagují na změnu podmínek prostředí?

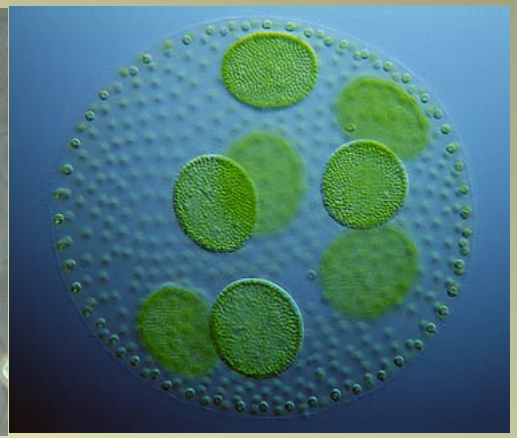


Ueki et al. 2010



Fototaxe u *Volvox rousseletii*



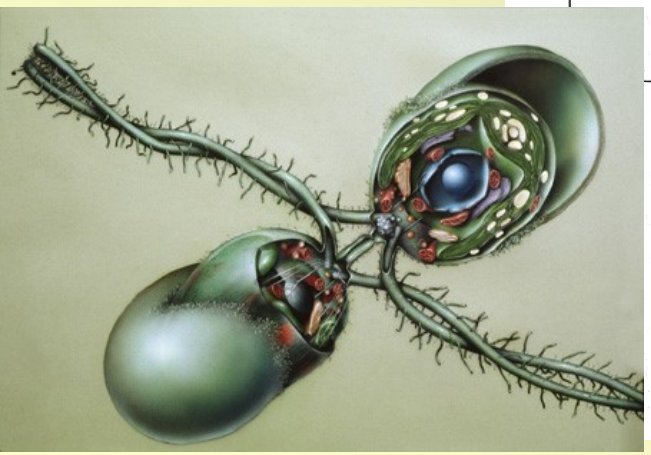


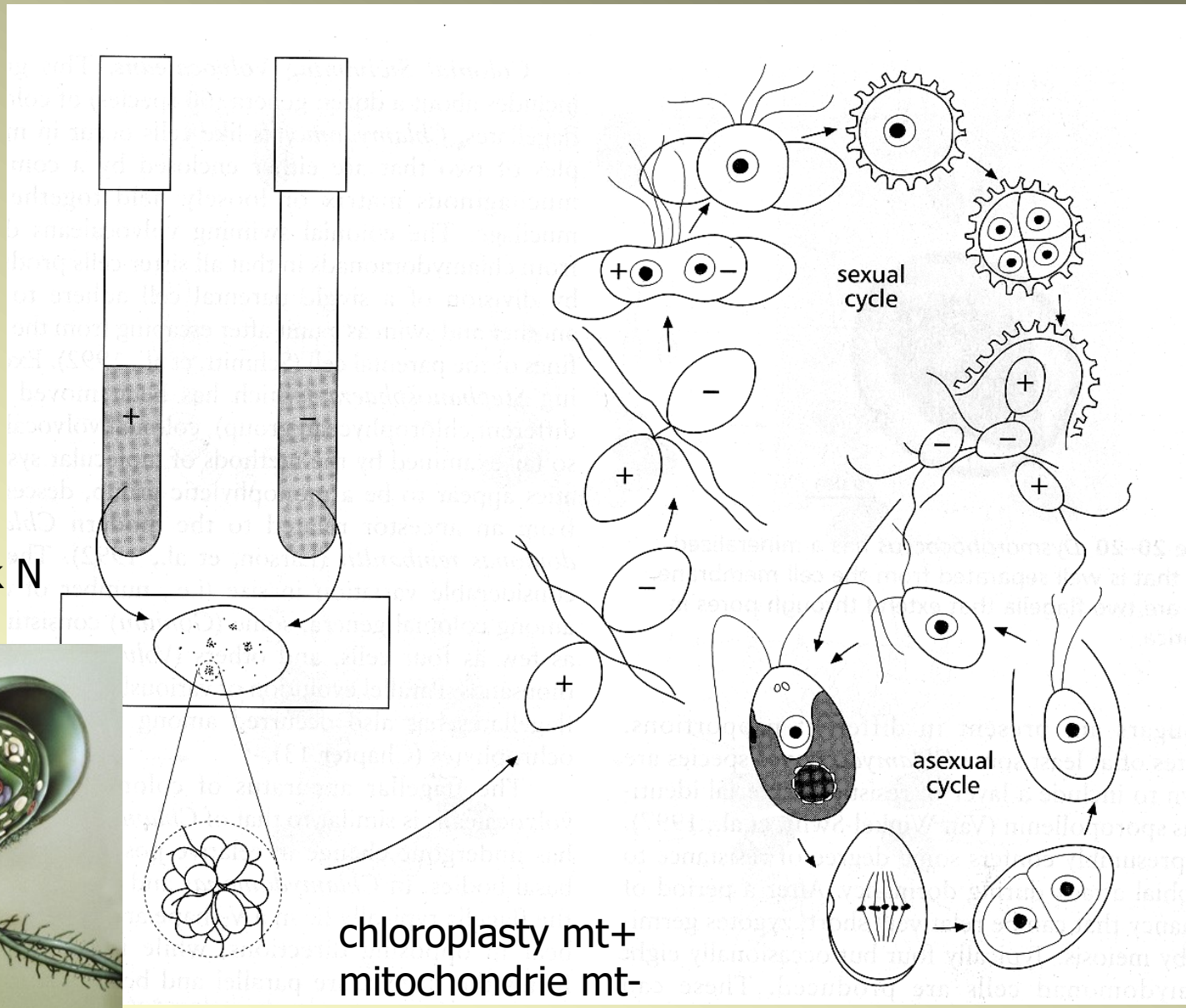
Jak plave *Volvox*?

Chlamydomonas

Ch. reinhardtii

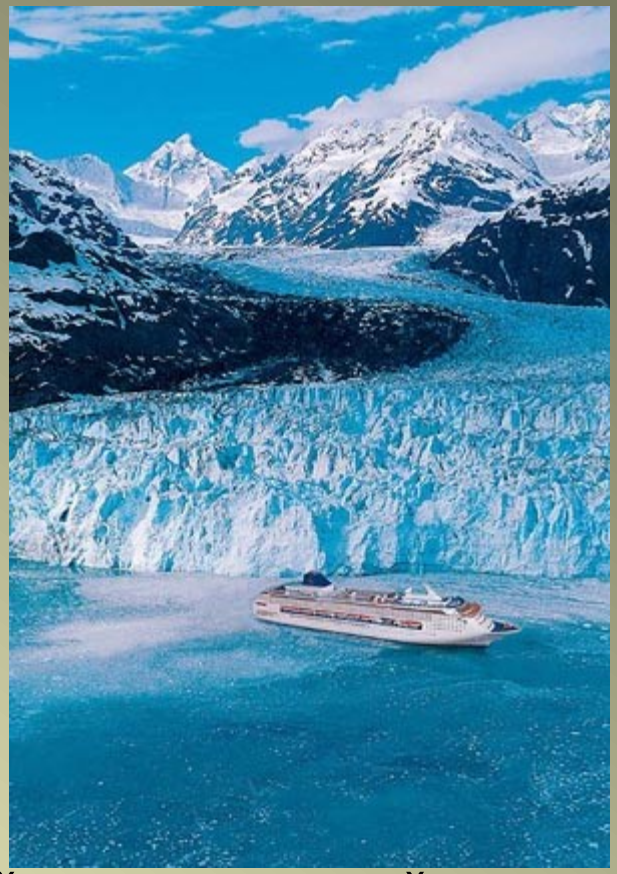
nedostatek N



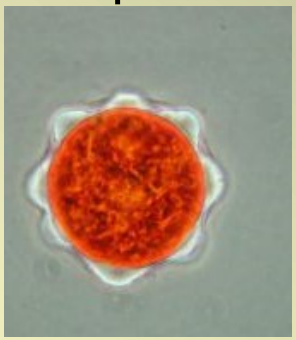


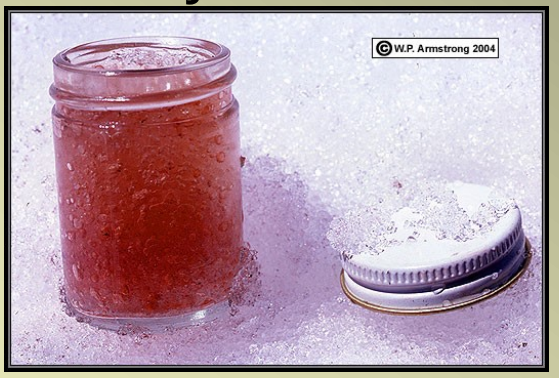
chloroplasty mt+
mitochondrie mt-

Chlamydomonas nivalis



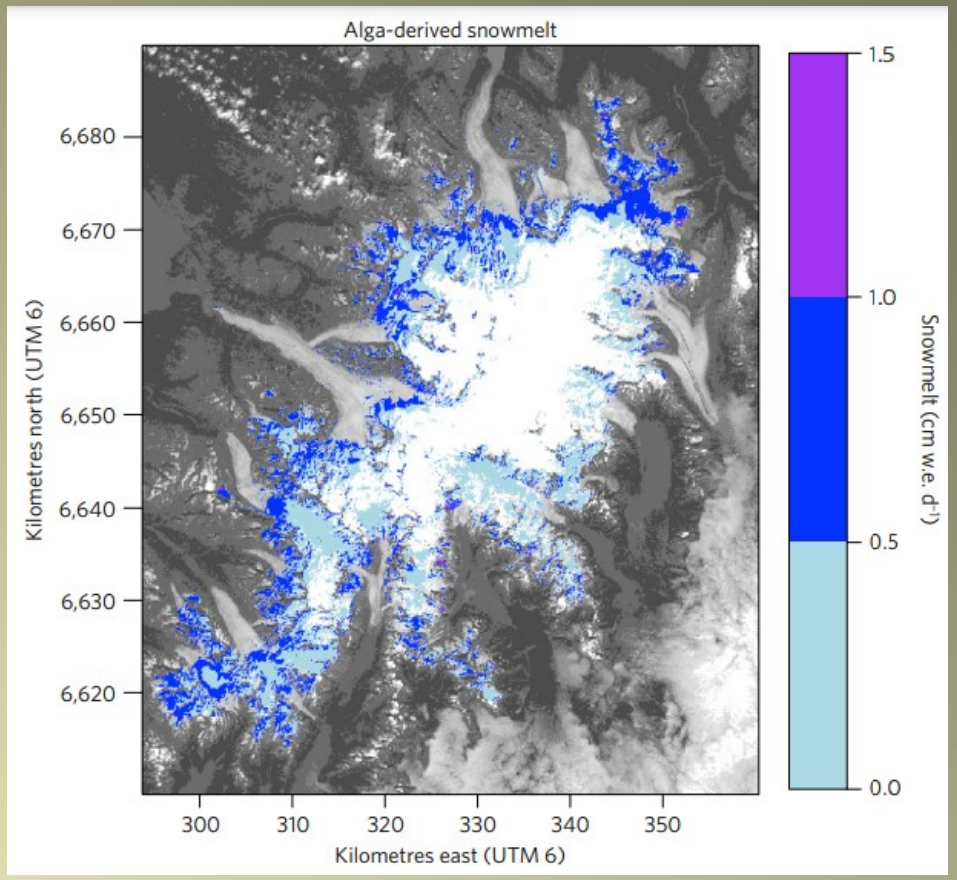
např. ledovce na Aljašce





watermelon snow

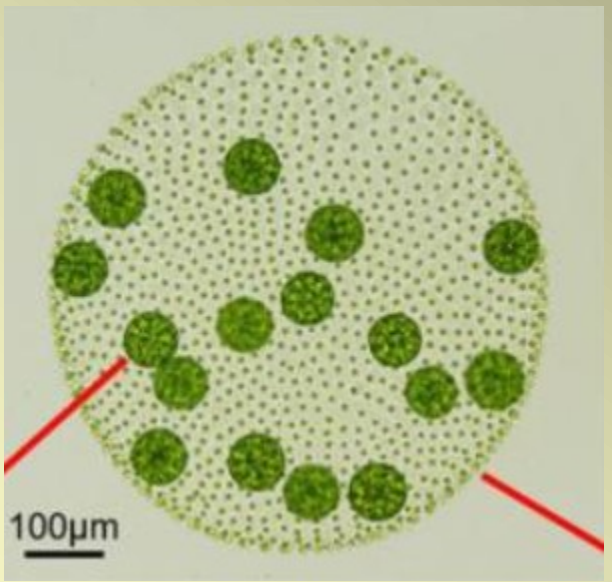
Ch. nivalis obsorbuje sluneční en. – zahřívá sebe i sníh kolem – snižuje odrazivost sněhu o 13%

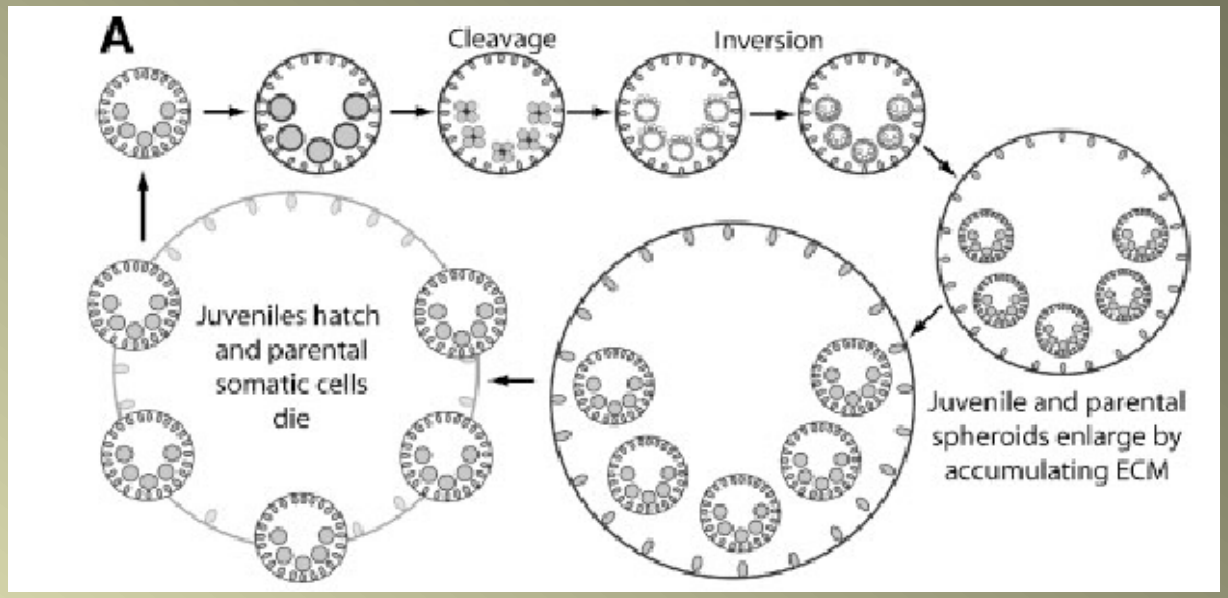


Odhad tání Harding Icefield na Aljašce (2013)

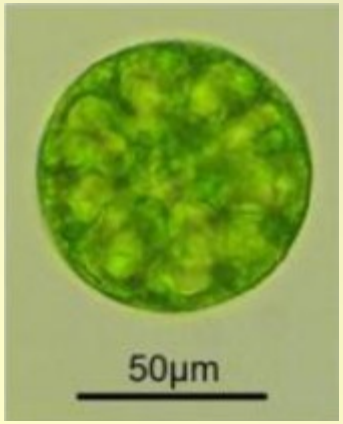
17% ročního tání je způsoveno řasovými nárosty (včetně *Ch. nivalis)*

Volvox carteri

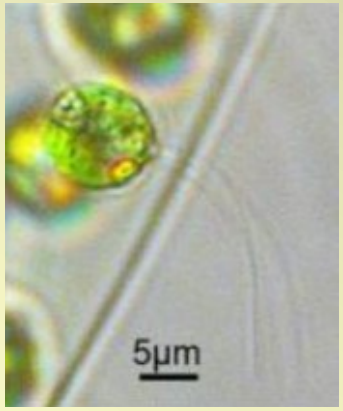




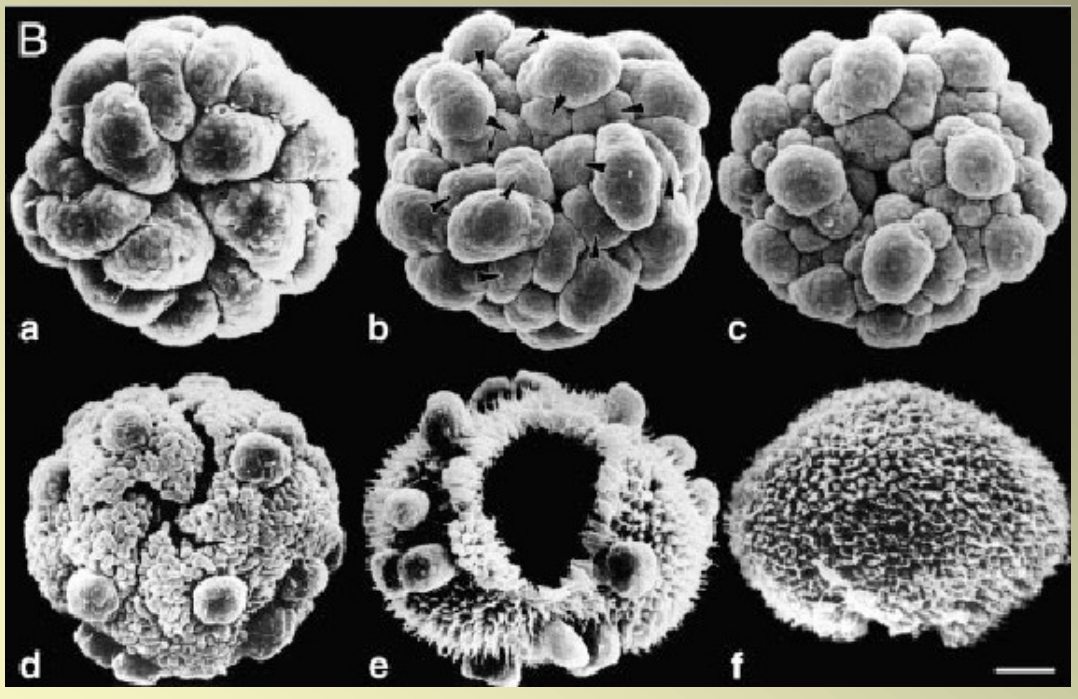
embryogeneze

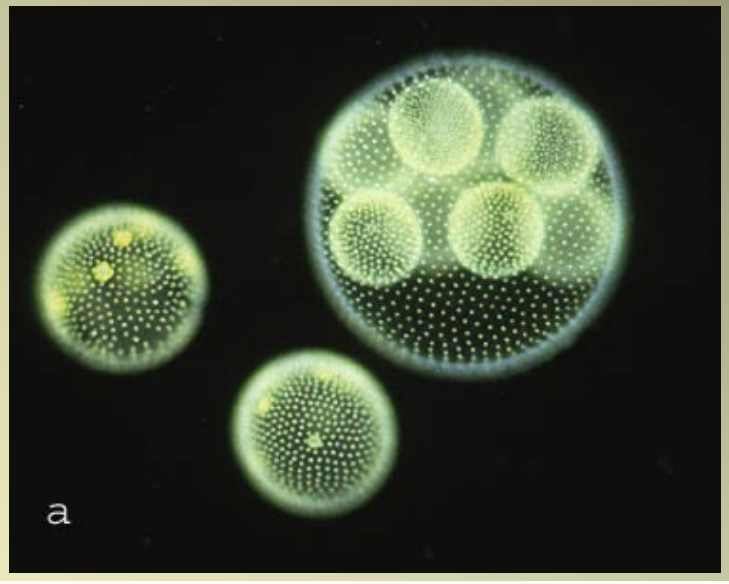


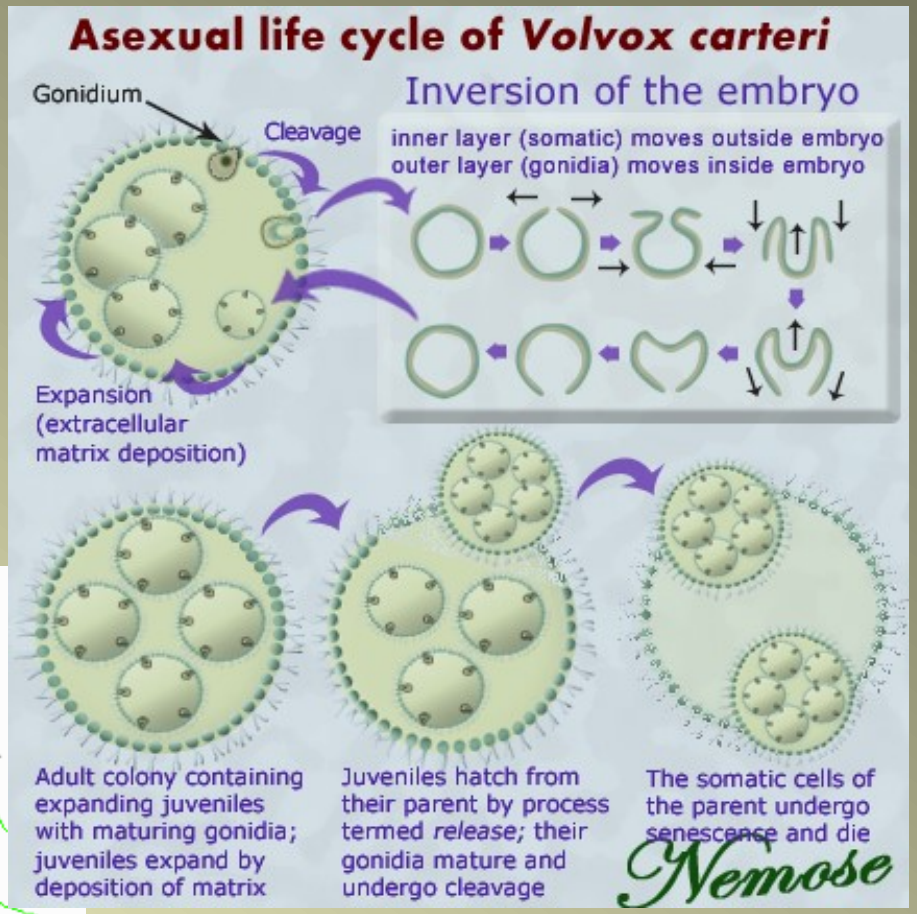
gonidium

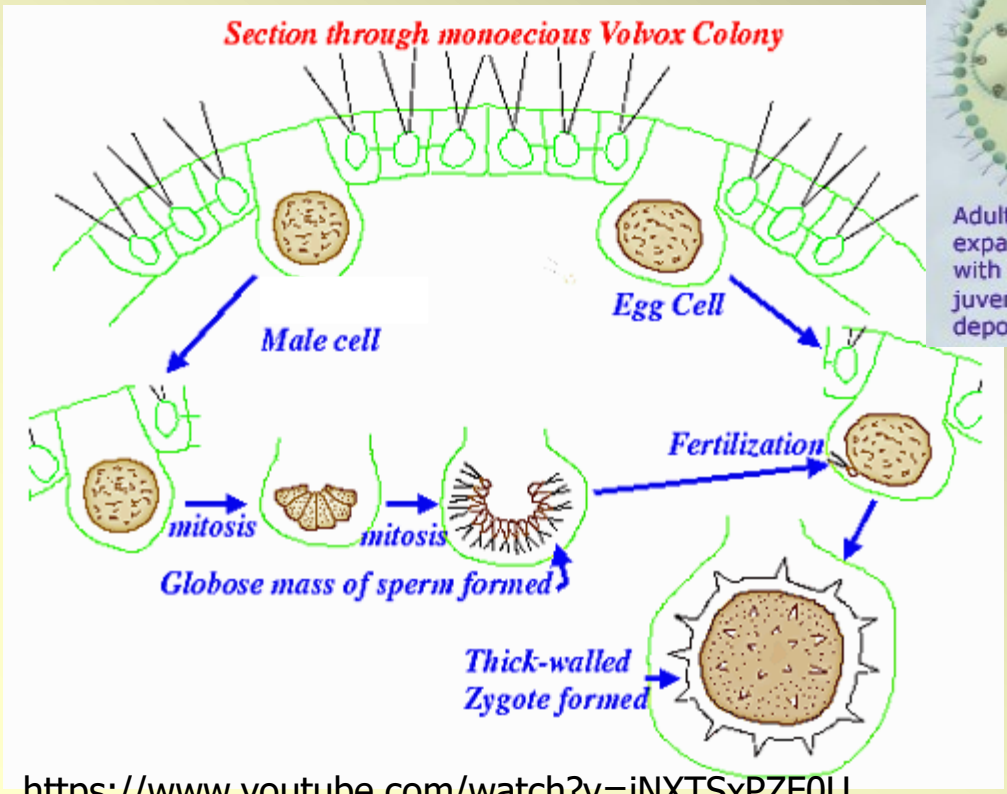


somatická buňka

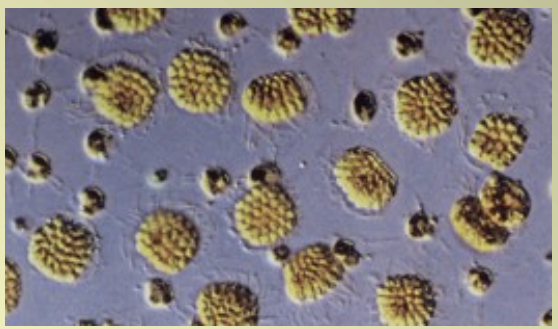






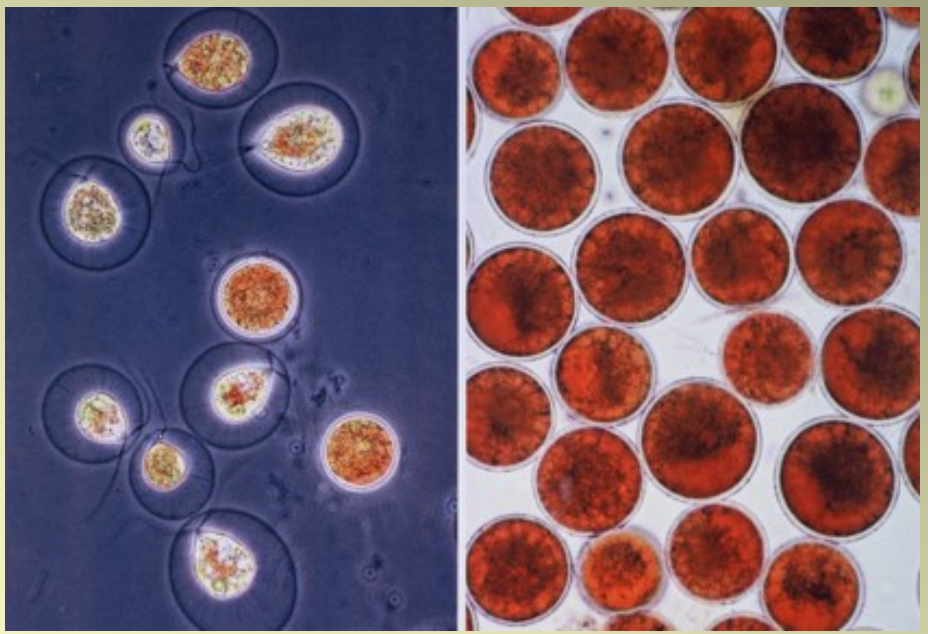


Volvox - váleč



https://www.youtube.com/watch?v=iNXTSxPZF0U

Haematococcus



Dunaliella

glycerol

ß - karoten

astaxanthin

Jezero Hillier záp. Austrálie

Halotolerance

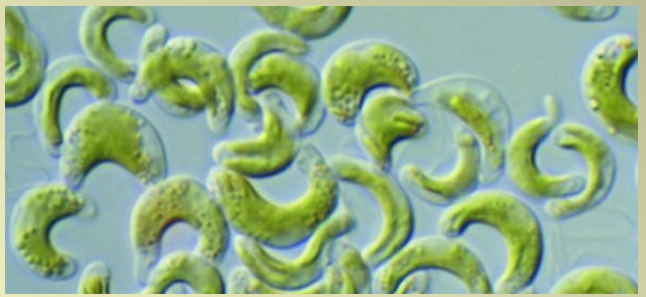
Dunaliella preferuje vodní prostředí se salinitou větší než 2M (10 %). Typicky lze jednodruhové kultury *Dunaliella* nalézt v hypersalinních jezerech jako je Mrtvé Moře (Israel), Great Salt Lake (Utah, USA), Pink Lake (Austrálie). Dosud nebyl zjištěn žádný eukaryontní organismus s vyšší halotolerancí.

Laguna Colorada – rezervace Eduardo Avaroa, v jihozápadním cípu Bolívie

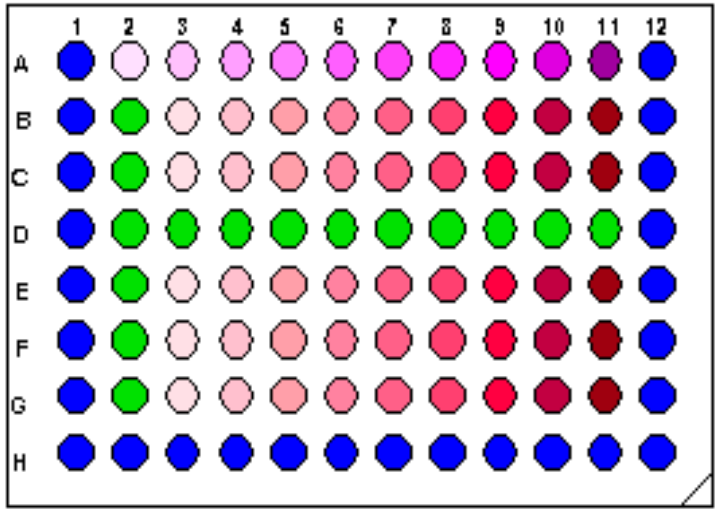
Pink Lake (západní Austrálie) hypersalinní jezero s *Halobacterium*

Třída: *Chlorophyceae*

Selenastrum capricornutum -
řasové biotesty

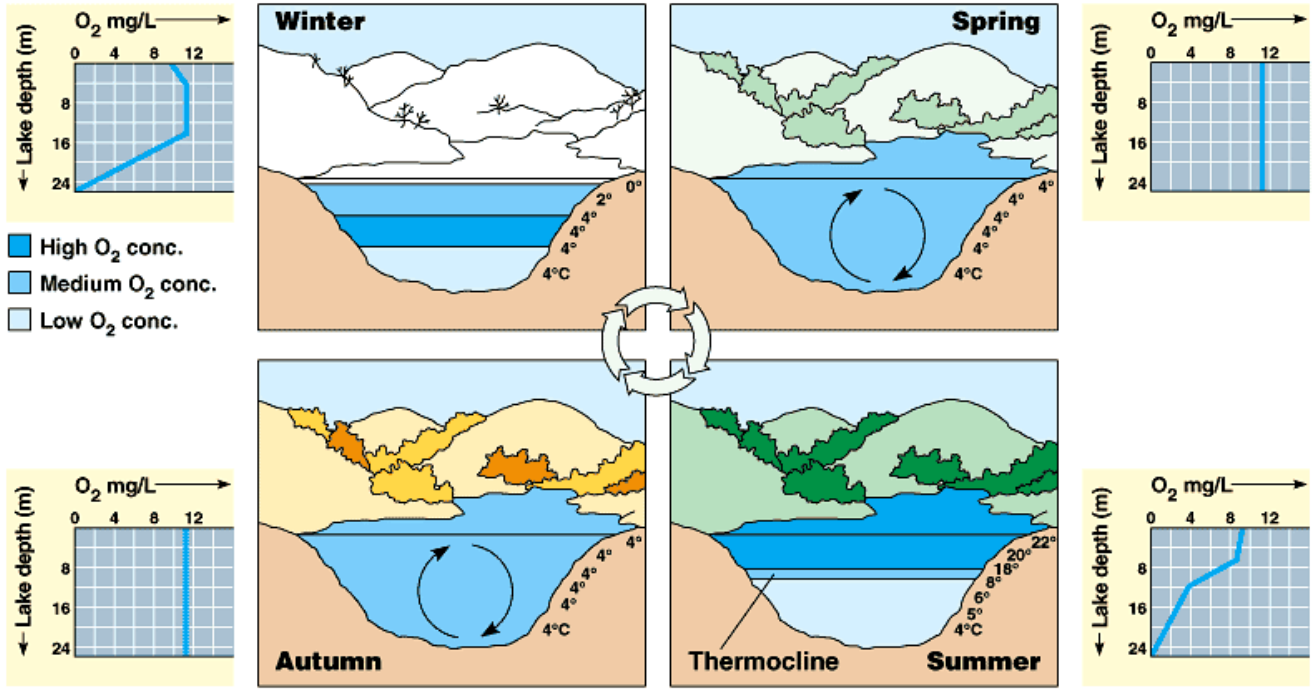


Sledování inhibičního a stimulačního účinku různých látek (např. sledování chronické toxicity odpadních vod, vlivu herbicidů na primární producenty)

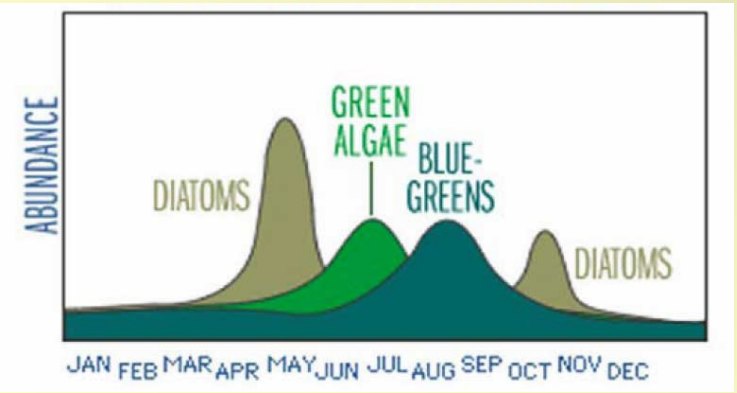


Obr. 1 – Schéma dávkování roztoků do jamek mikrotitrační destičky

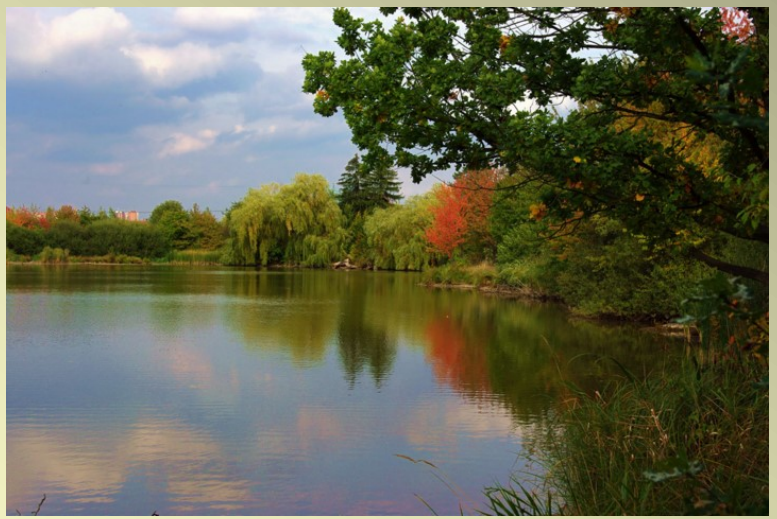
teplotní stratifikace temperátních jezer



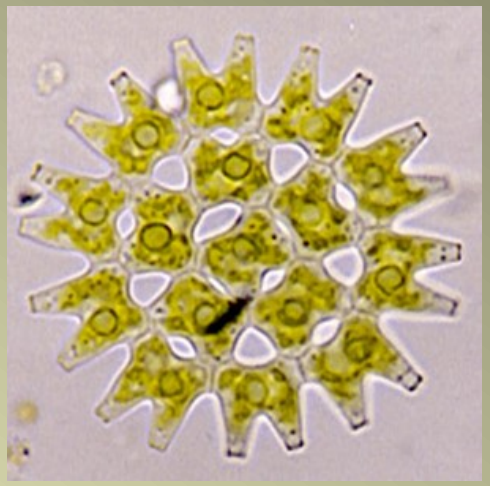
dominance jednotlivých skupin řas

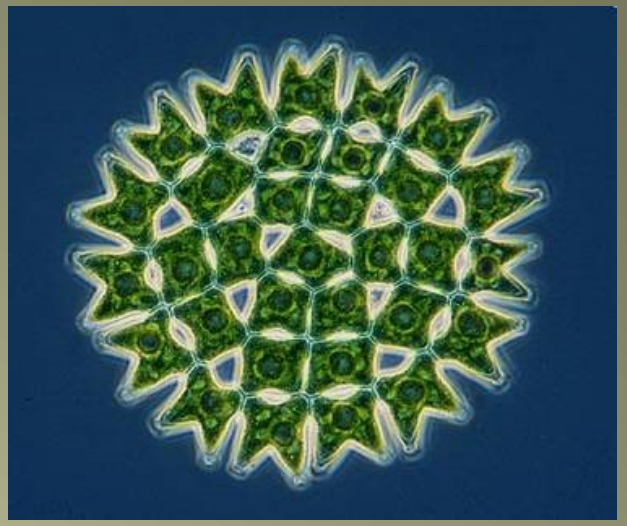


Pediastrum

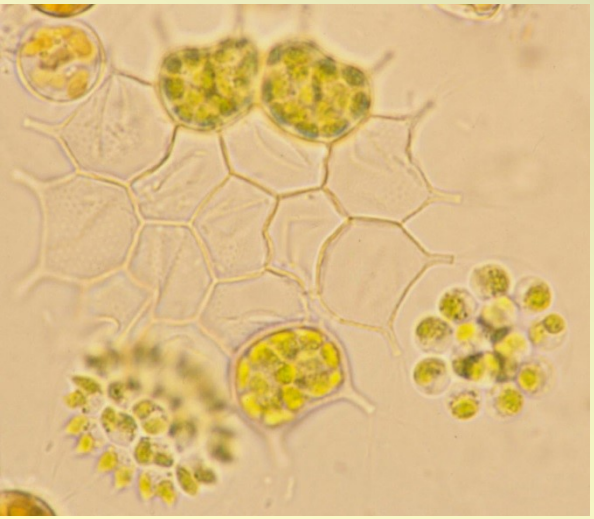


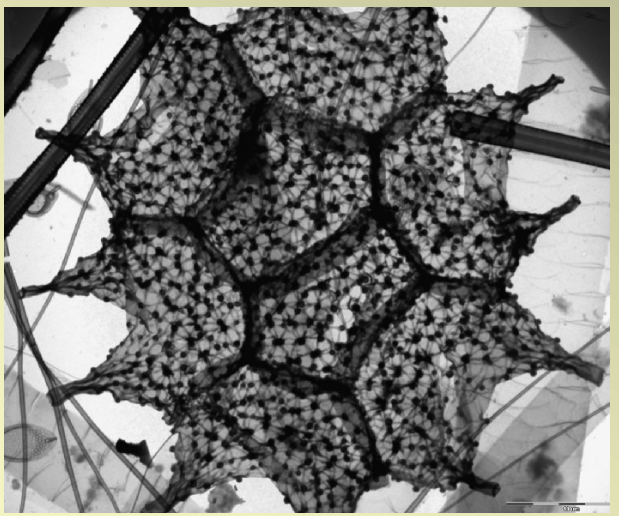
cenobium





https://www.youtube.com/watch?v=Bzxd4YBsIfI



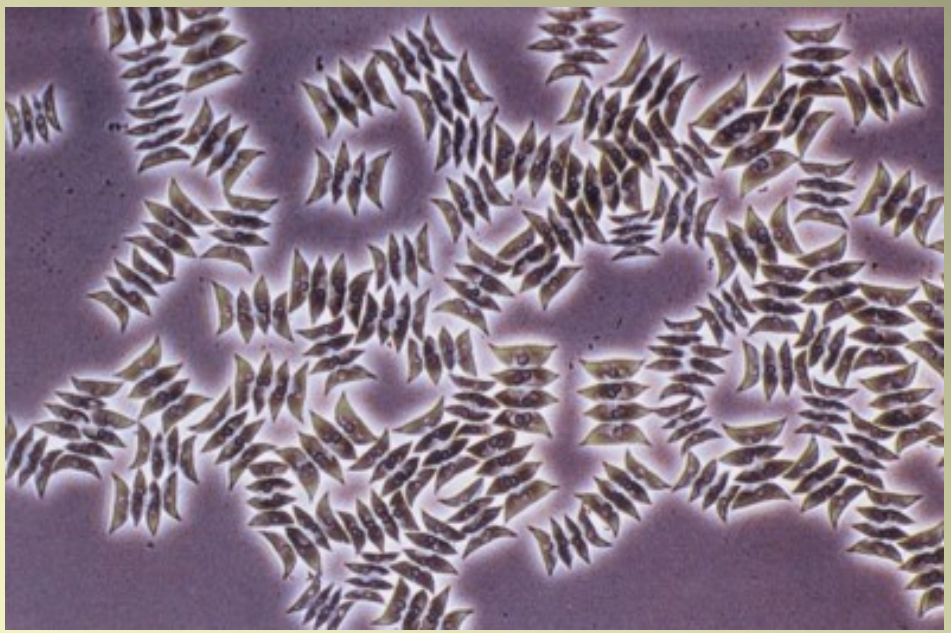


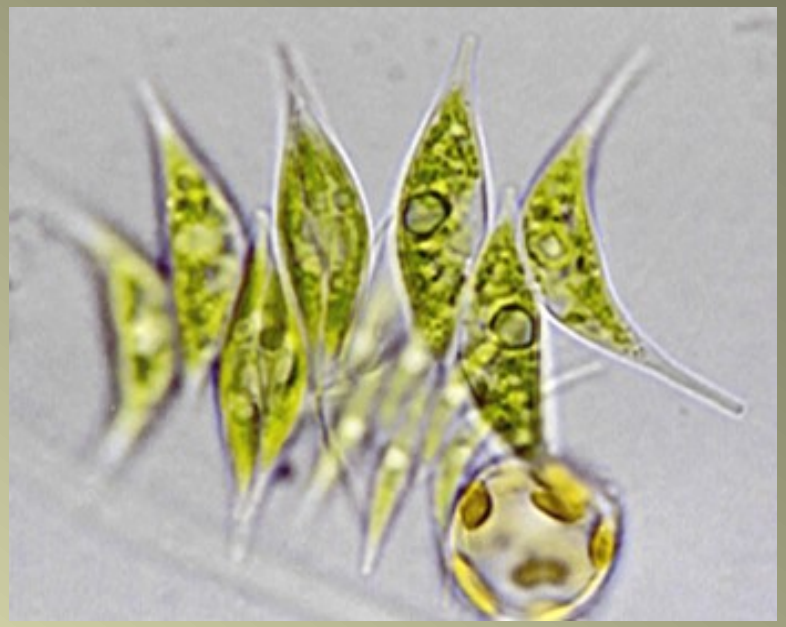
Pseudopediastrum

zoospory

acetorezistentní biopolymer - algenan, paleoekologie

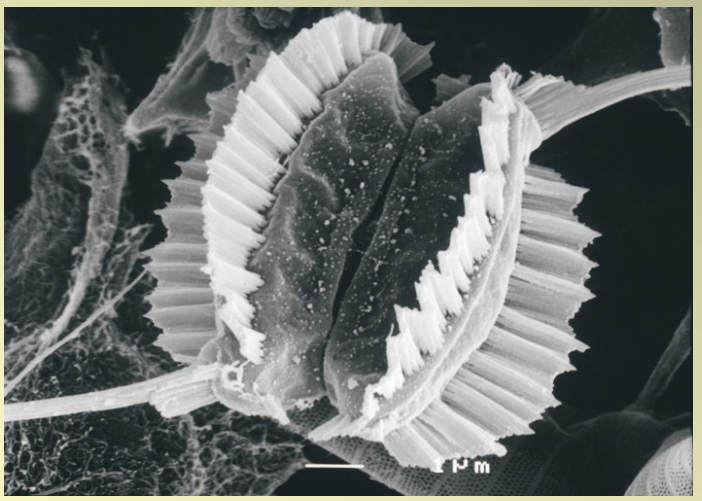
Scenedesmus - deskovka

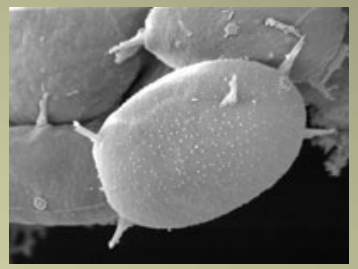




fenoplasticita

Desmodesmus



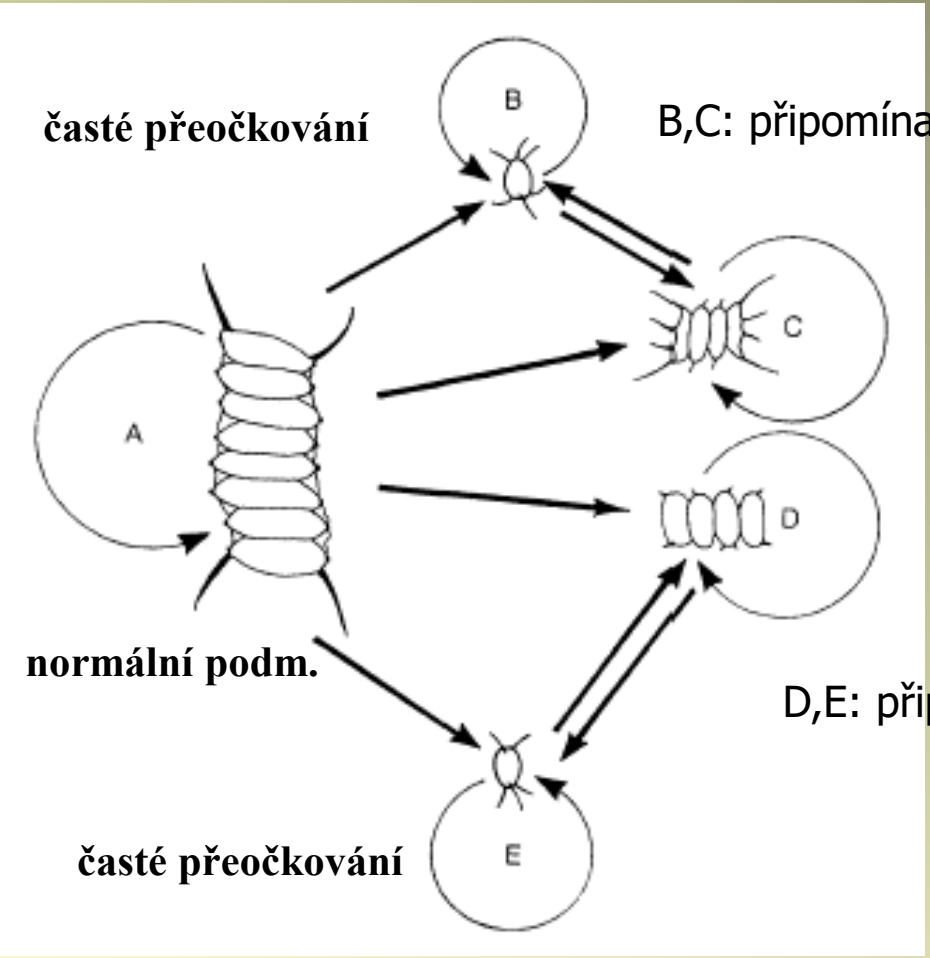


Fenotypová plasticita

Co ovlivňuje přeměnu jedné formy v jinou?

hustota kultury, přítomnost predátorů (informačních molekul)

D. communis

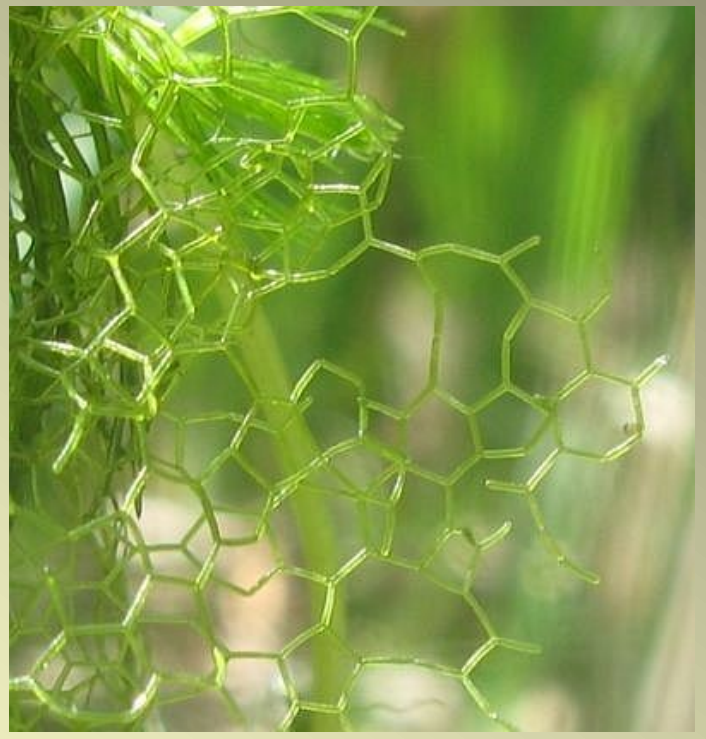


Trainor, F. R. 1991 . Discovering the various ecomorphs of Scenedesmus. The end of a taxonomic era. Arch. Protistenkd. 139: 125-132.

Hydrodictyon – vodní síť

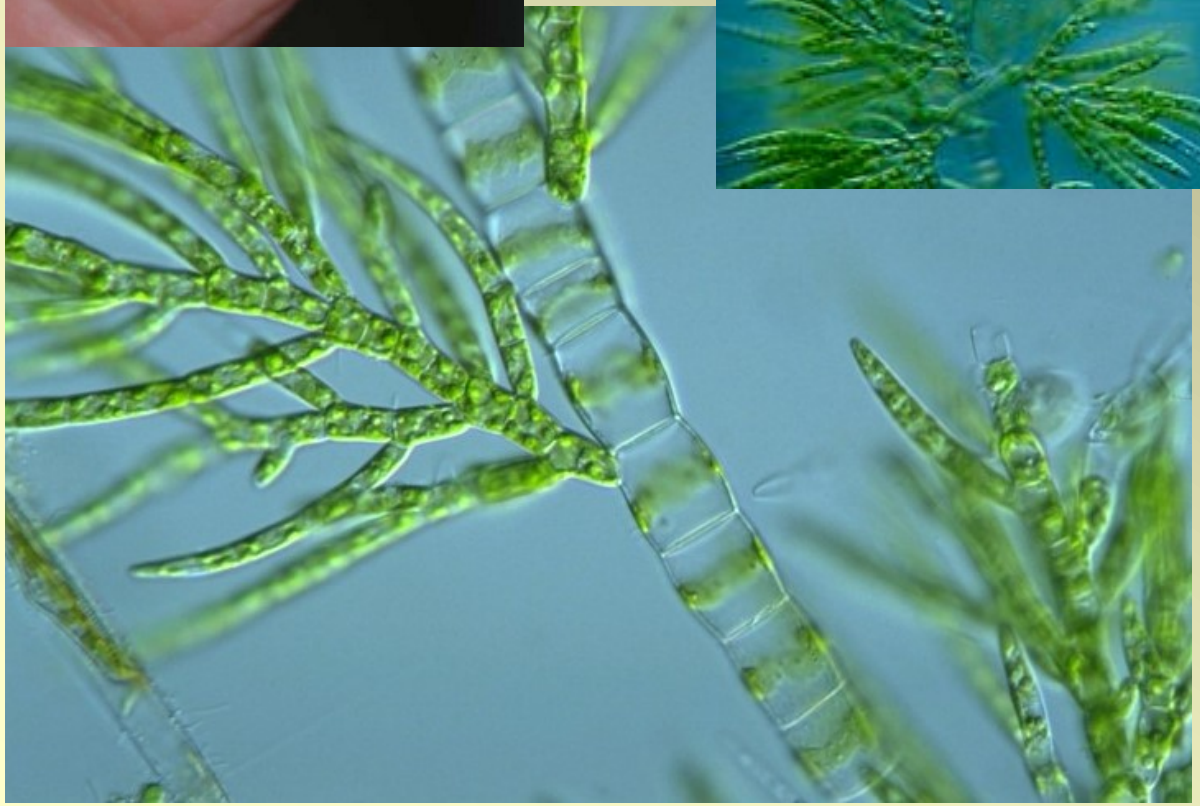
Plovoucí shluky *Hydrodictyon* (červenec 2009 Keston Pond, near Bromley, Kent, UK).

invazní druh - síťovité cenobium 1m x 4-6cm



Rybník nedaleko Českých Budějovic sloužící jako ptačí rezervace, který byl doslova zamořen rozsáhlými porosty zelené řasy rodu *Hydrodictyon*.
Foto: Petr Znachor

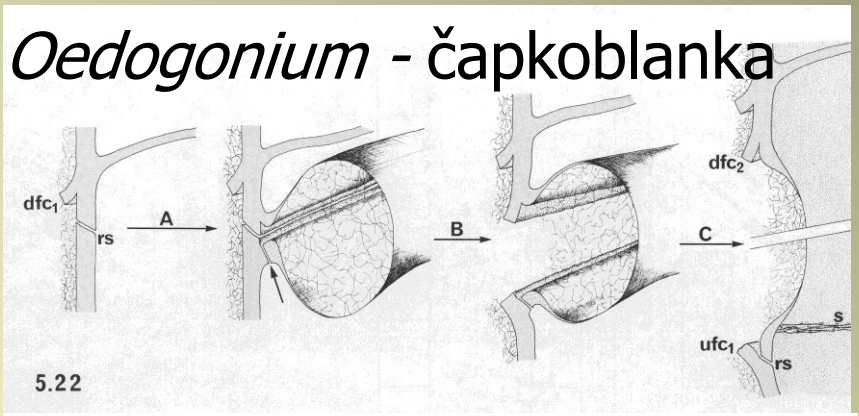
Draparnaldia

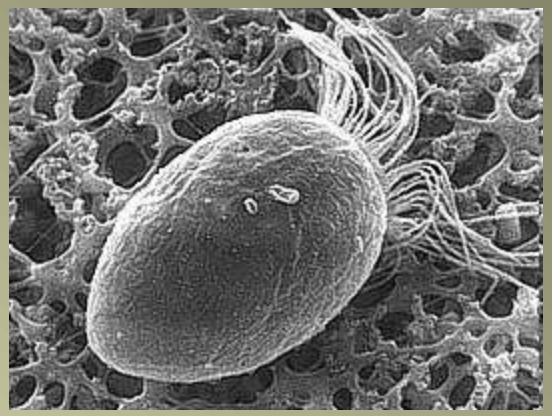


v čistých tekoucích i stojatých vodách

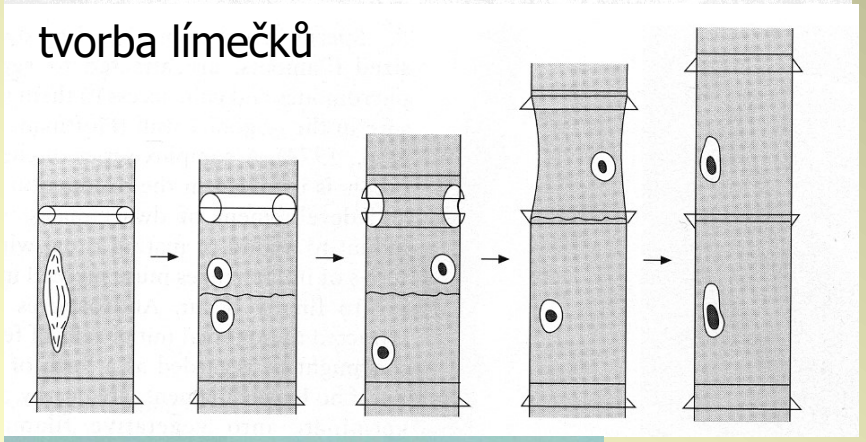
Třída: *Chlorophyceae*

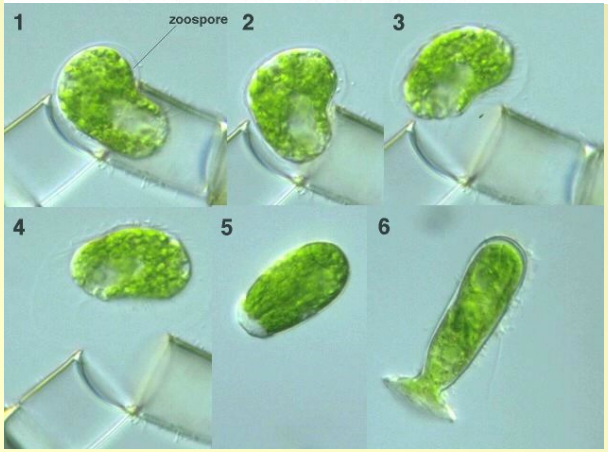
Oedogonium - čapkoblanka





tvorba límečků

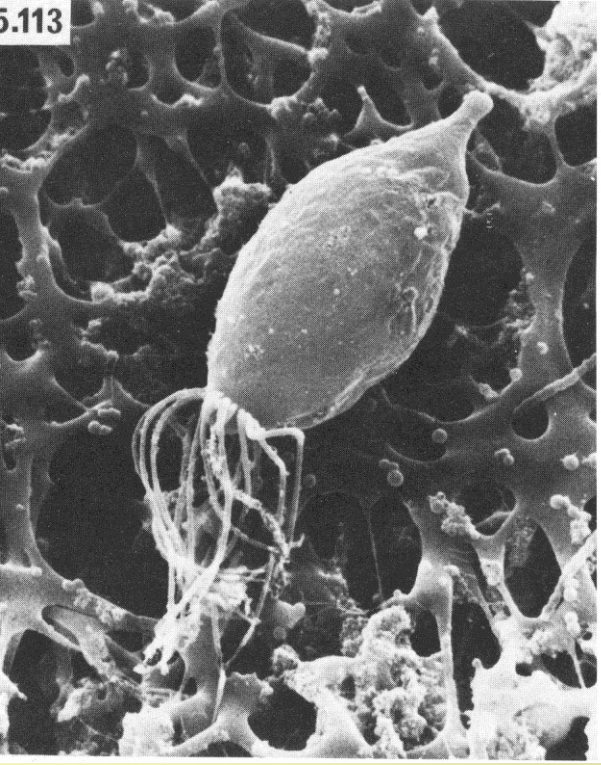


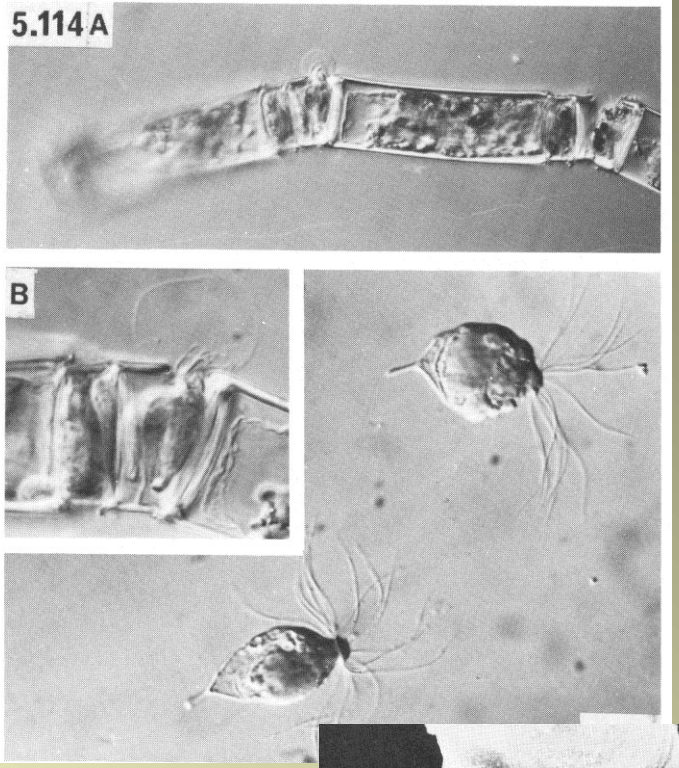


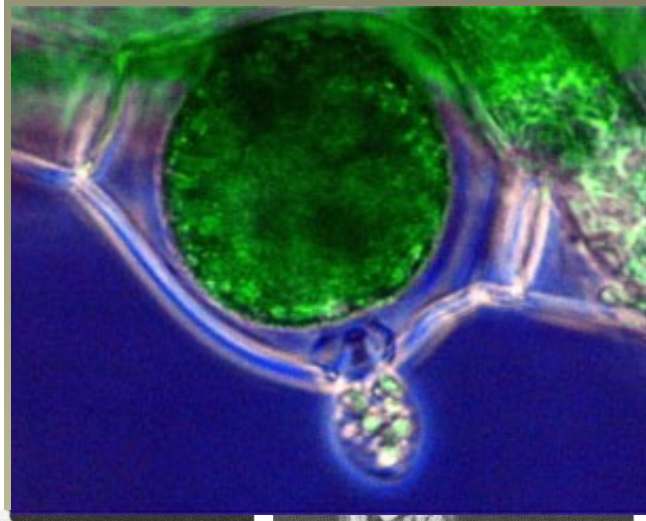
stefanokontní zoospora

popsáno 550 druhů

Oedogonium





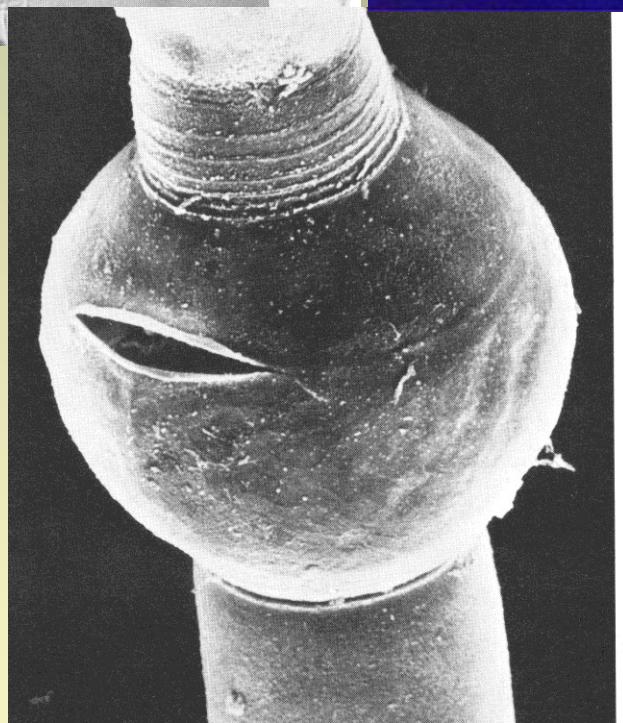


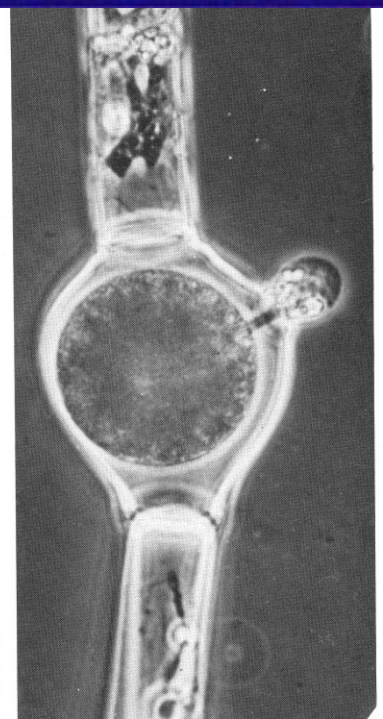
spermatogeneze *O.cardiacum*

feromon

oogonium s oplozovacím pórem (mikropyle)

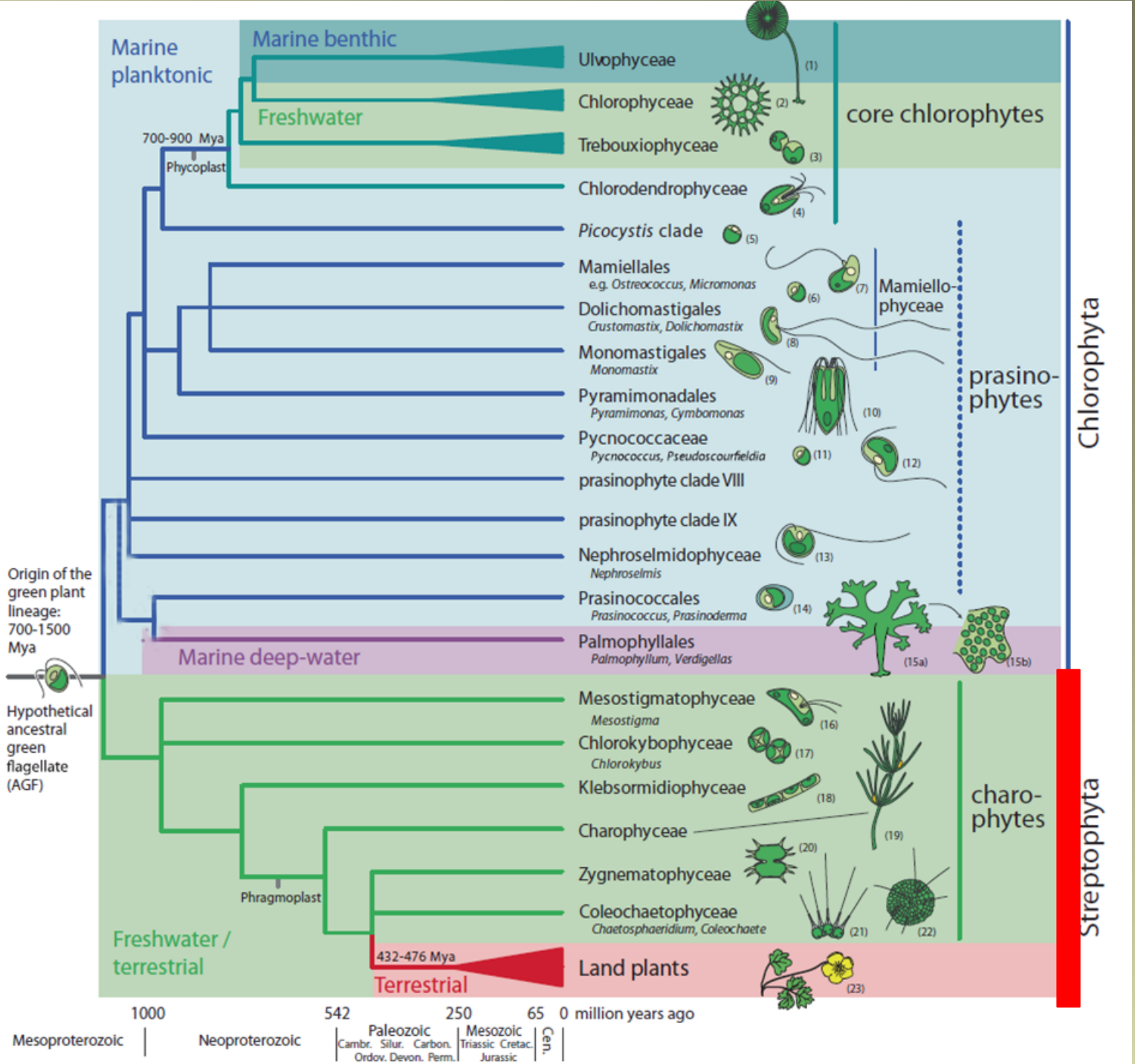
zralá zygospora s ostnitou BS





Stefanokontní zoospora

http://www.youtube.com/watch?v=Oh0E-Afl0_A

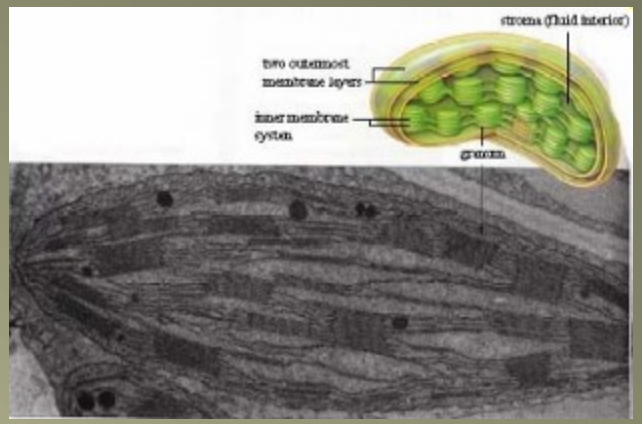

Marine planktonic
Marine benthic
Freshwater
700-900 Mya
Phycoplast
Ulvophyceae
Chlorophyceae
Trebouxiophyceae
core chlorophytes
Chlorodendrophyceae
Picocystis clade
Mamiellales
e.g. Ostreococcus, Micromonas
Dolichomastigales
Crustomastix, Dolichomastix
Monomastigales
Monomastix
Pyramimonadales
Pyramimonas, Cymbomonas
Pycnococcaceae
Pycnococcus, Pseudoscourfieldia
prasinophyte clade VIII
prasinophyte clade IX
Nephroselmidophyceae
Nephroselmis
Prasinococcales
Prasinococcus, Prasinoderma
Palmophyllales
Palmophyllum, Verdigellas
Mamiello-phyceae
prasino-phytes
Chlorophyta
Origin of the green plant lineage: 700-1500 Mya
Marine deep-water
Hypothetical ancestral green flagellate (AGF)
Mesostigmatophyceae
Mesostigma
Chlorokybophyceae
Chlorokybus
Klebsormidiophyceae
Charophyceae
Zygnematophyceae
Coleochaetophyceae
Chaetosphaeridium, Coleochaete
charo-phytes
Phragmoplast
Freshwater / terrestrial
432-476 Mya
Terrestrial
Land plants
Streptophyta
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(15a)
(15b)
(16)
(17)
(18)
(19)
(20)
(21)
(22)
(23)
1000
542
250
65
0 million years ago
Mesoproterozoic
Neoproterozoic
Paleozoic
Cambr. Silur. Carbon.
Ordov. Devon. Perm.
Mesozoic
Triassic Cretac.
Jurassic
Cen.

Kde v systému se nacházíme?

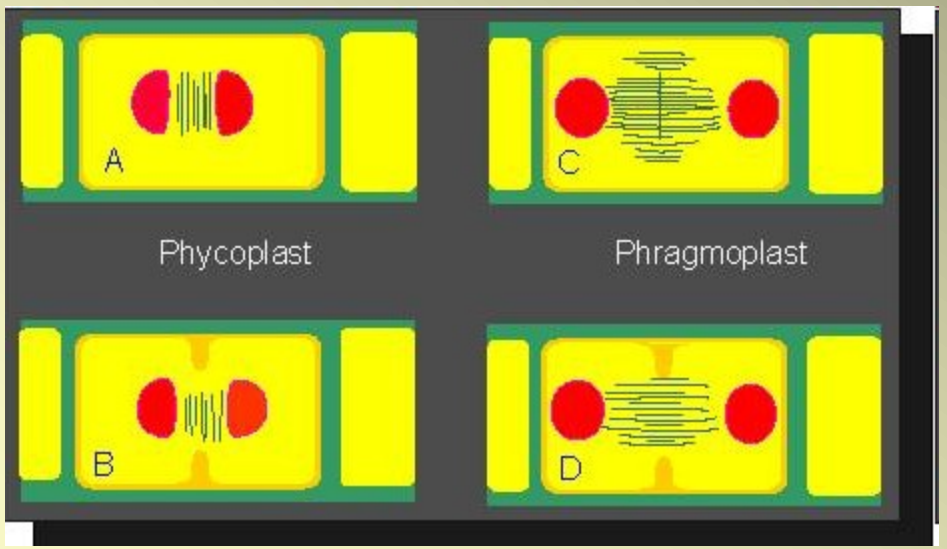
Eukaryota

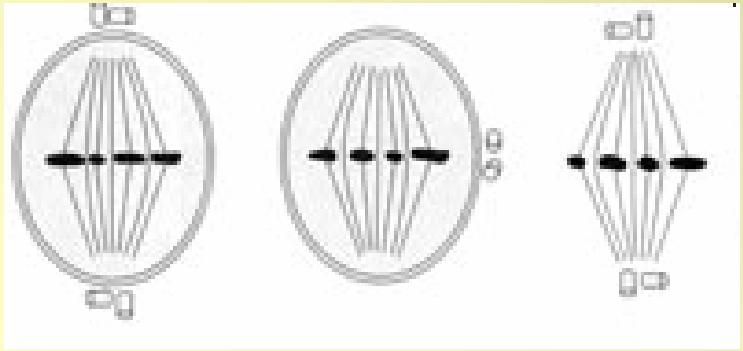
Archaeplastida

Chloroplastida



dvě vývojové linie - *Chlorophytae* a ***Streptophytae***

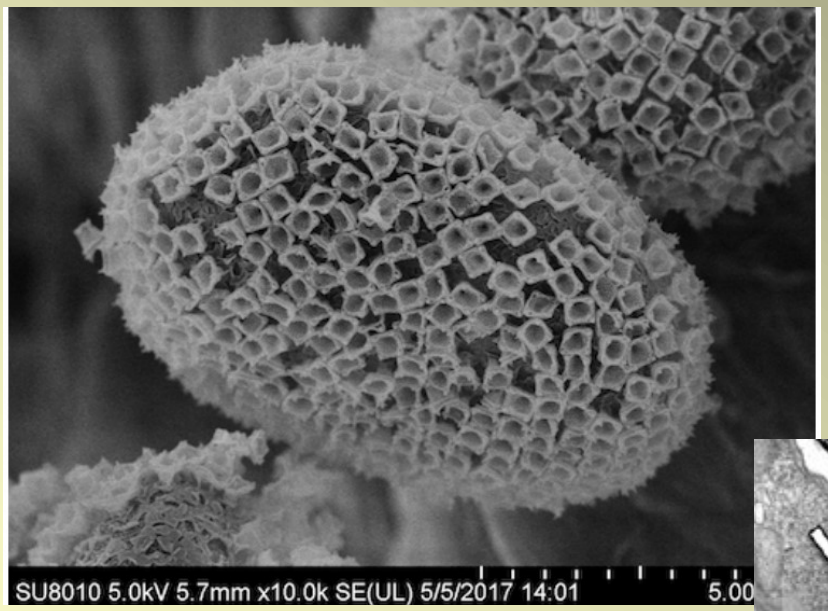


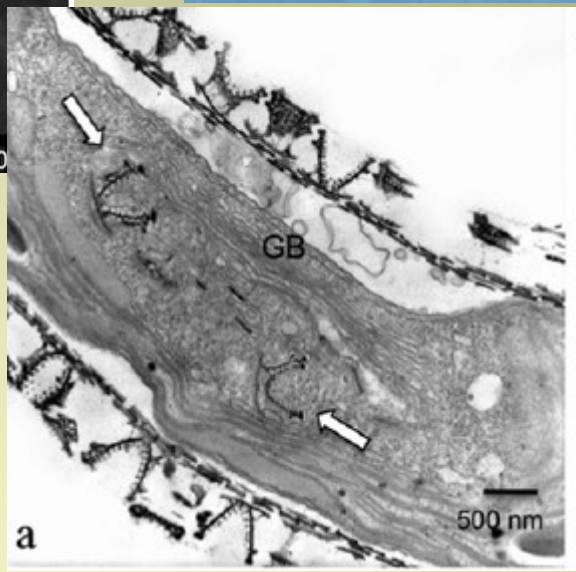


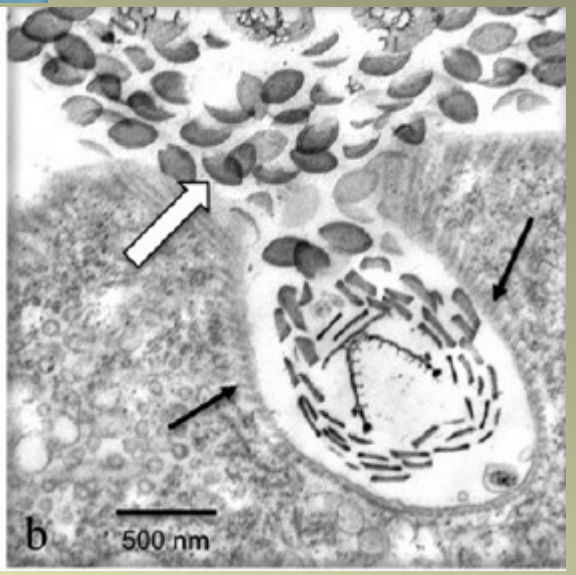
mechorosty a cévnaté rostliny se ze streptofytní linie začaly vyvíjet asi před 700 milióny lety

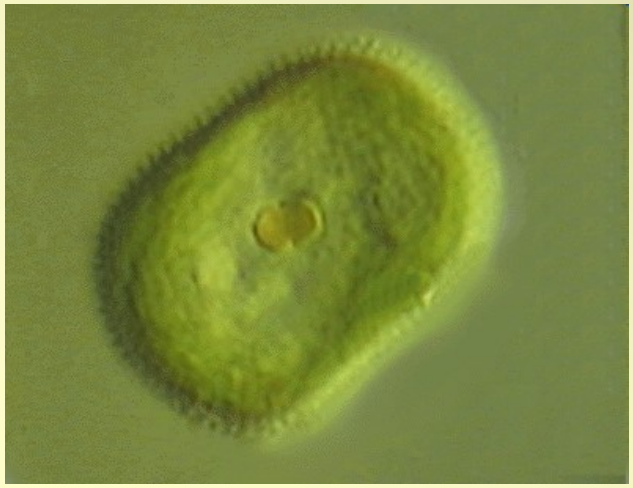
Třída: *Mesostigmatophyceae*

Mesostigma viride – na bázi streptofytní linie





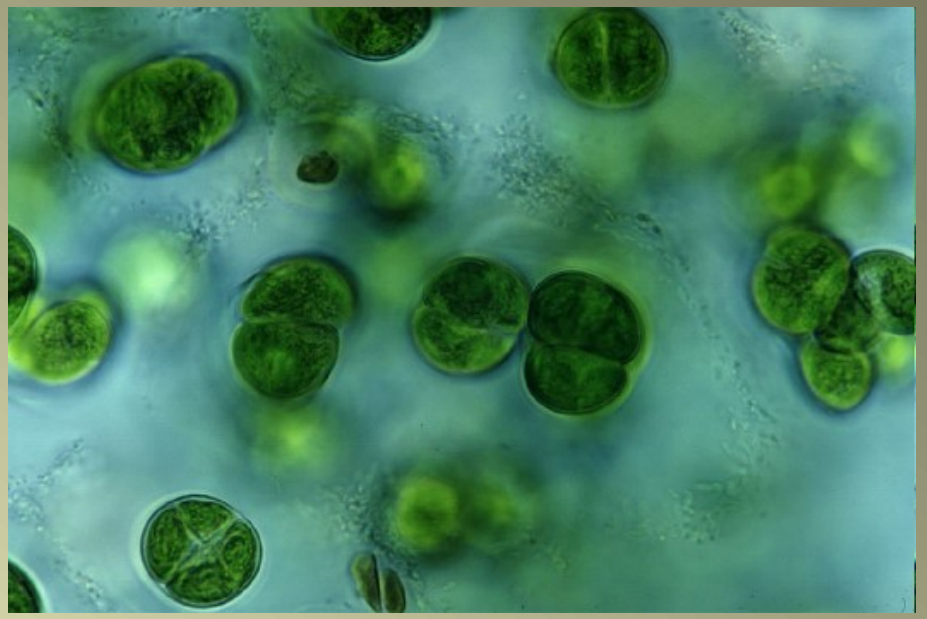




mesotrofní sladkovodní fytoplankton, tělo bičíkovce pokryté polysacharidovými šupinami

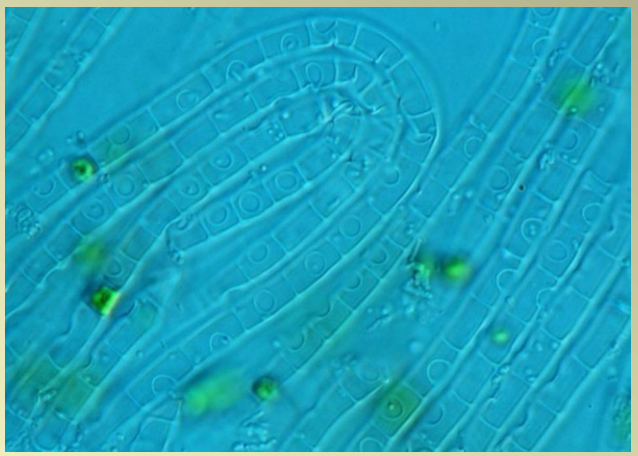
Třída: *Chlorokybophyceae*

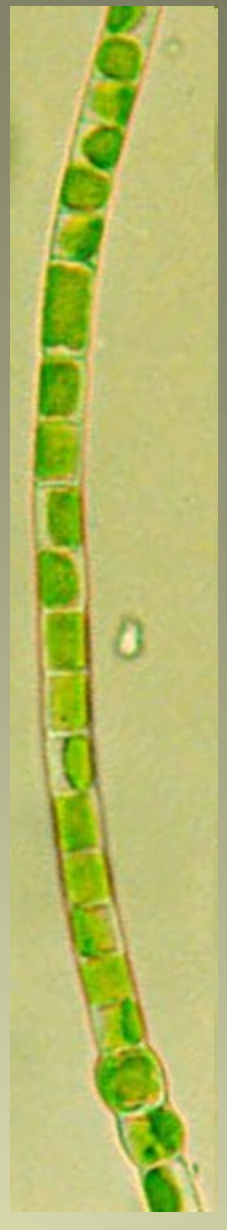
Chlorokybus atmophyticus

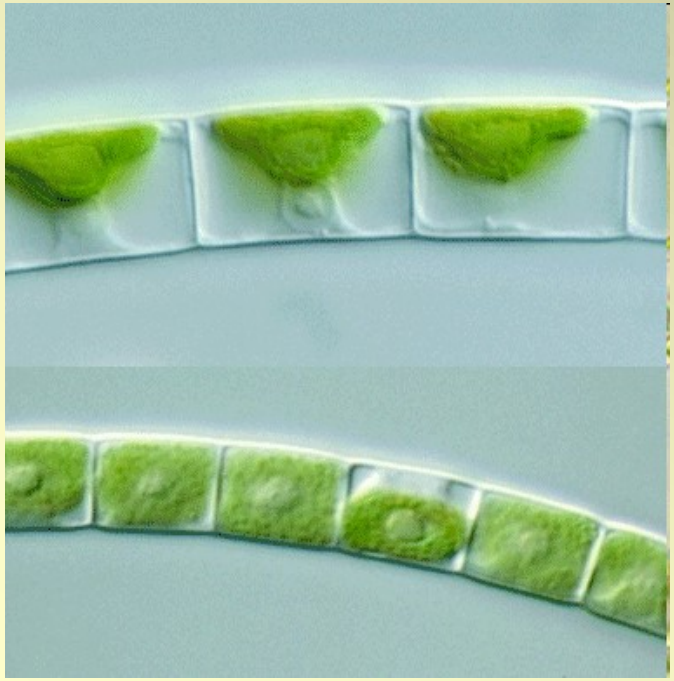


Alpy, vápencové krasy

Třída: *Klebsormidiophyceae*





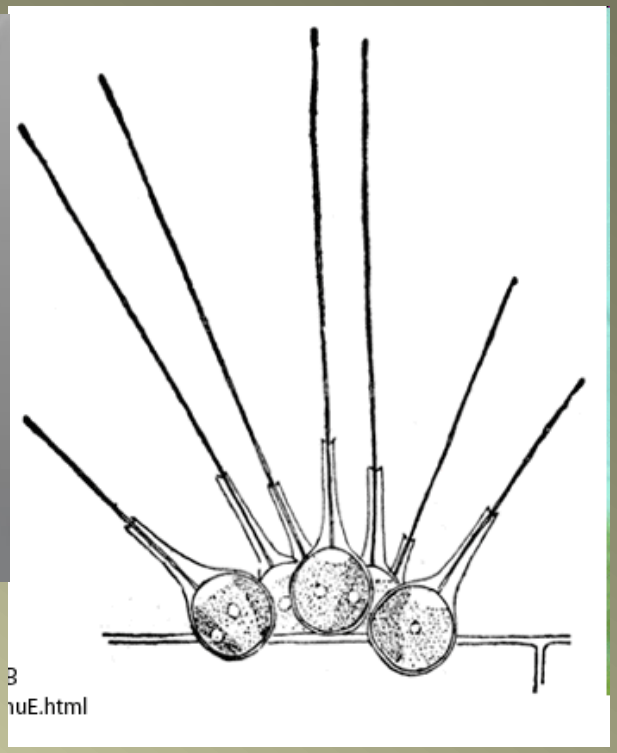


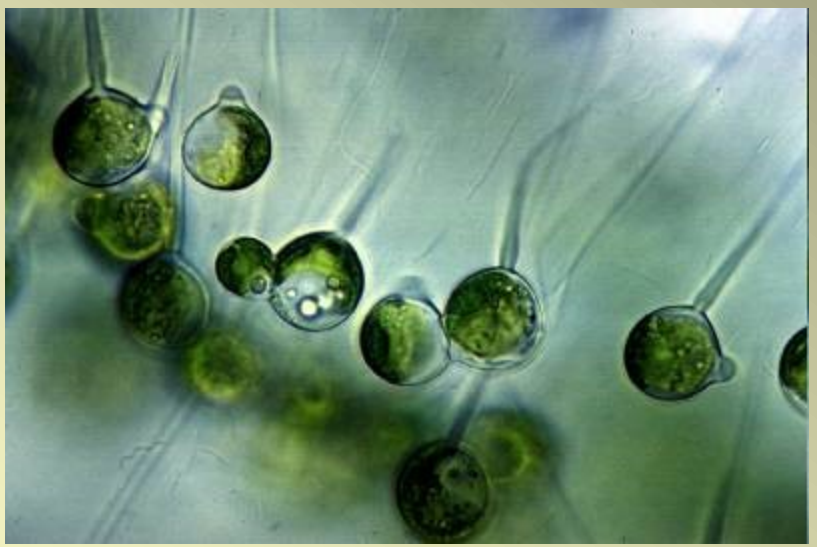
součástí řasových biofilmů

nejčastěji se vyskytující řasa v aero-terestrických biotopech

Chaetosphaeridium

skupina sesterská k Zygnematophyceae???



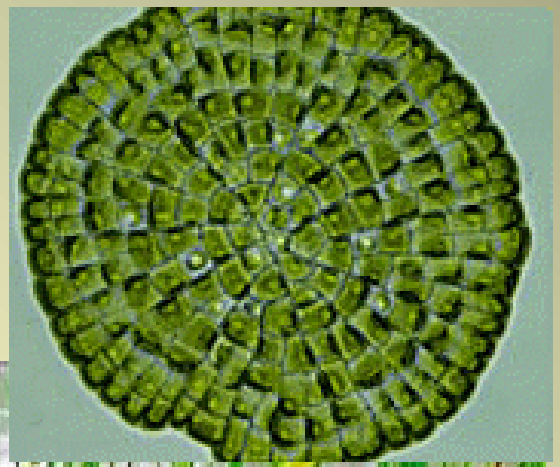


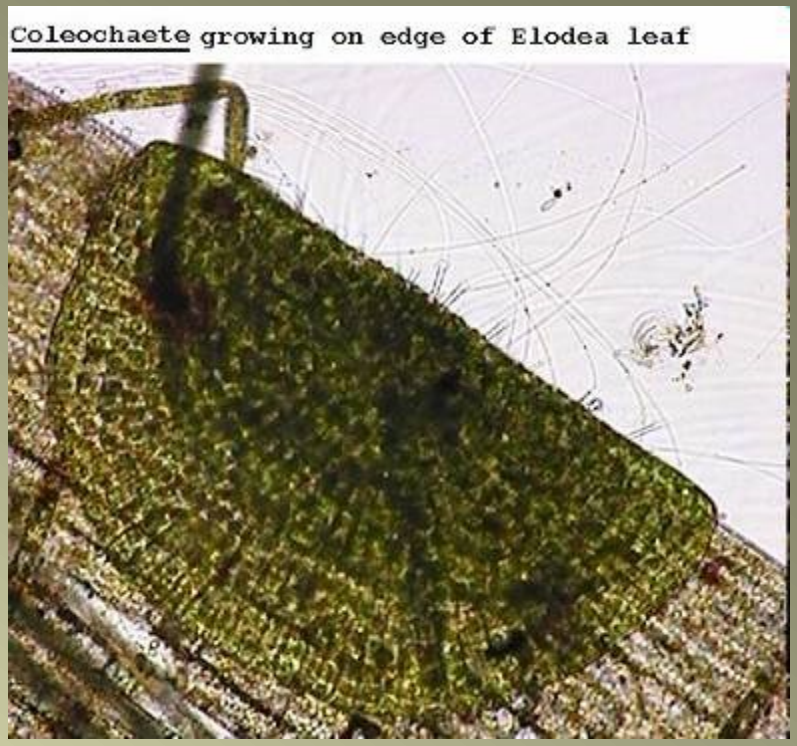
epifyt na vláknech sladkovodních řas, kolonie spojená dutými trubicemi

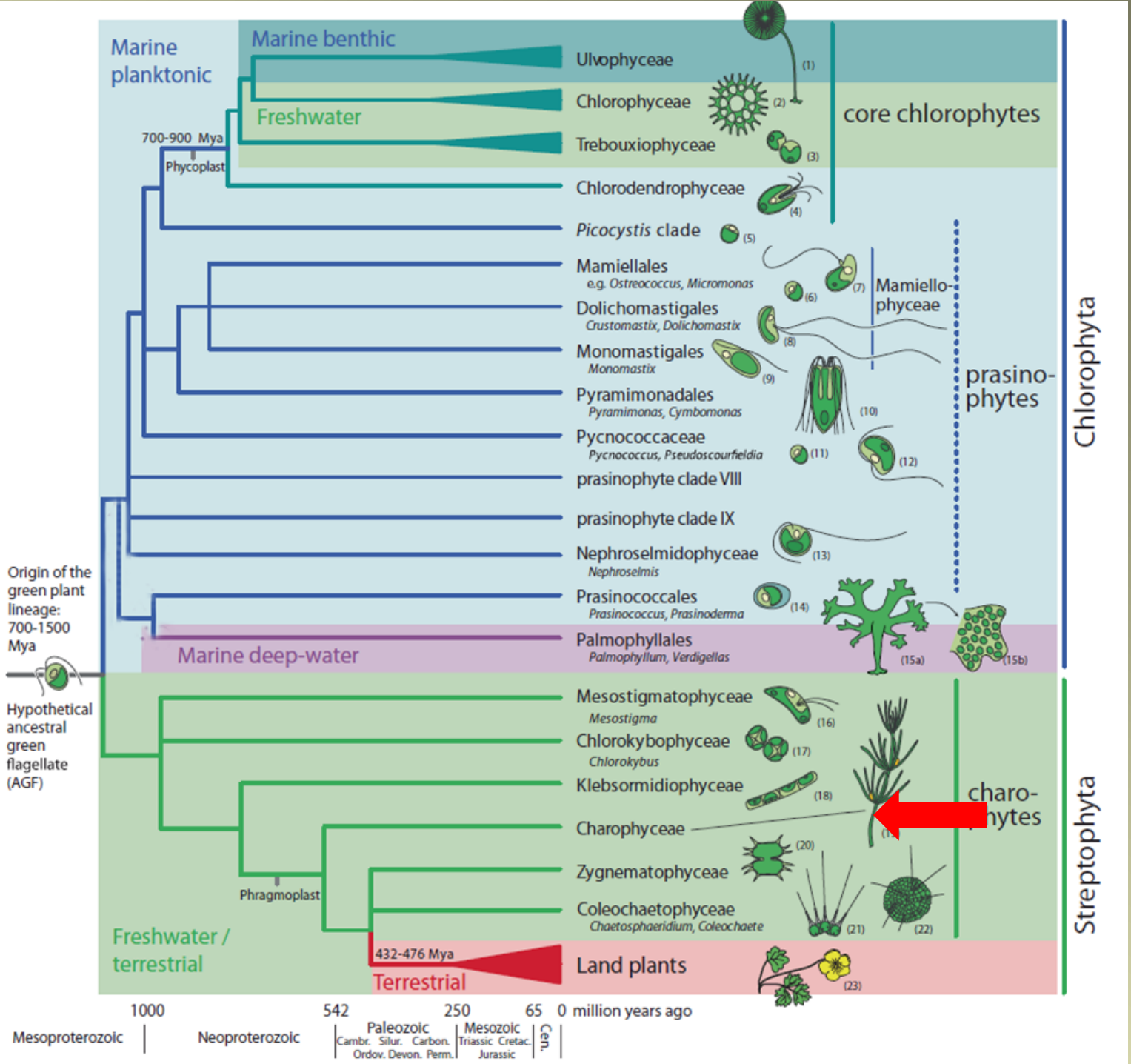
Třída: *Coleochaetophyceae*

meso-oligotrofní jezera
pohlavní proces oogamie

Coleochaete






Marine planktonic
Marine benthic
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700-900 Mya
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Chlorophyceae
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Mamiellales
e.g. Ostreococcus, Micromonas
Dolichomastigales
Crustomastix, Dolichomastix
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Mesozoic
Triassic Cretac.
Jurassic
Cen.

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Eukaryota

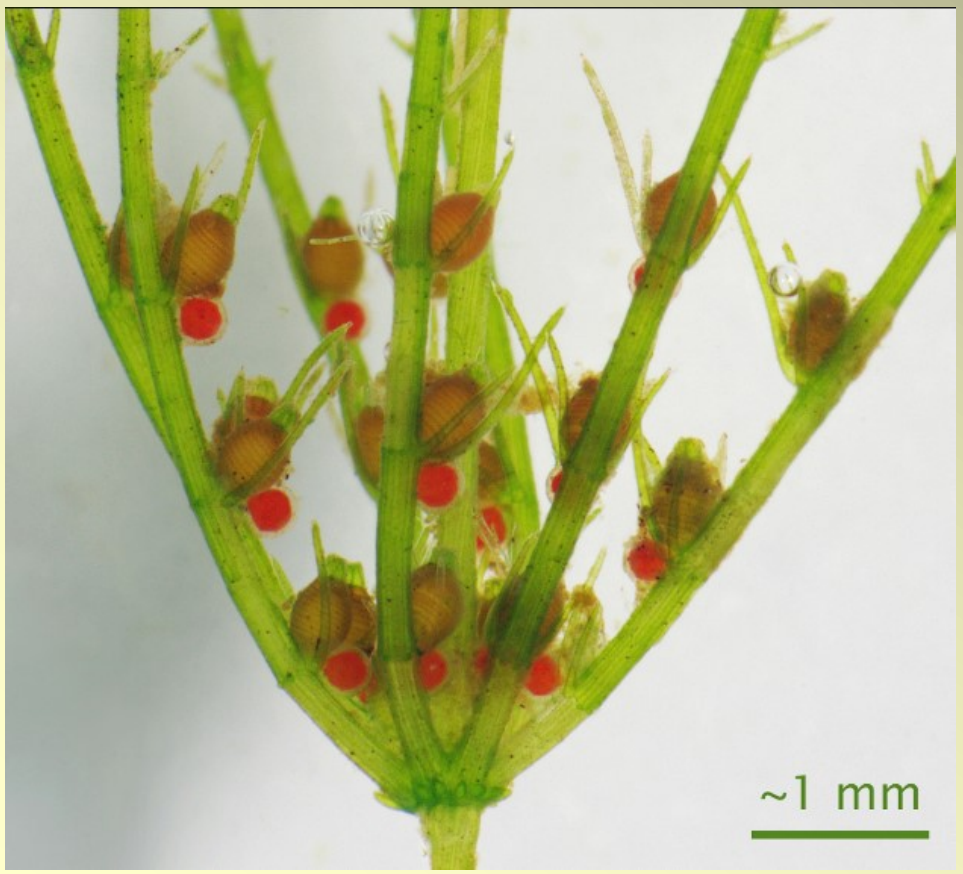
Archaeplastida

Chloroplastida

vývojová linie - *Streptophytae*

Třída: *Charophyceae* - parožnatky

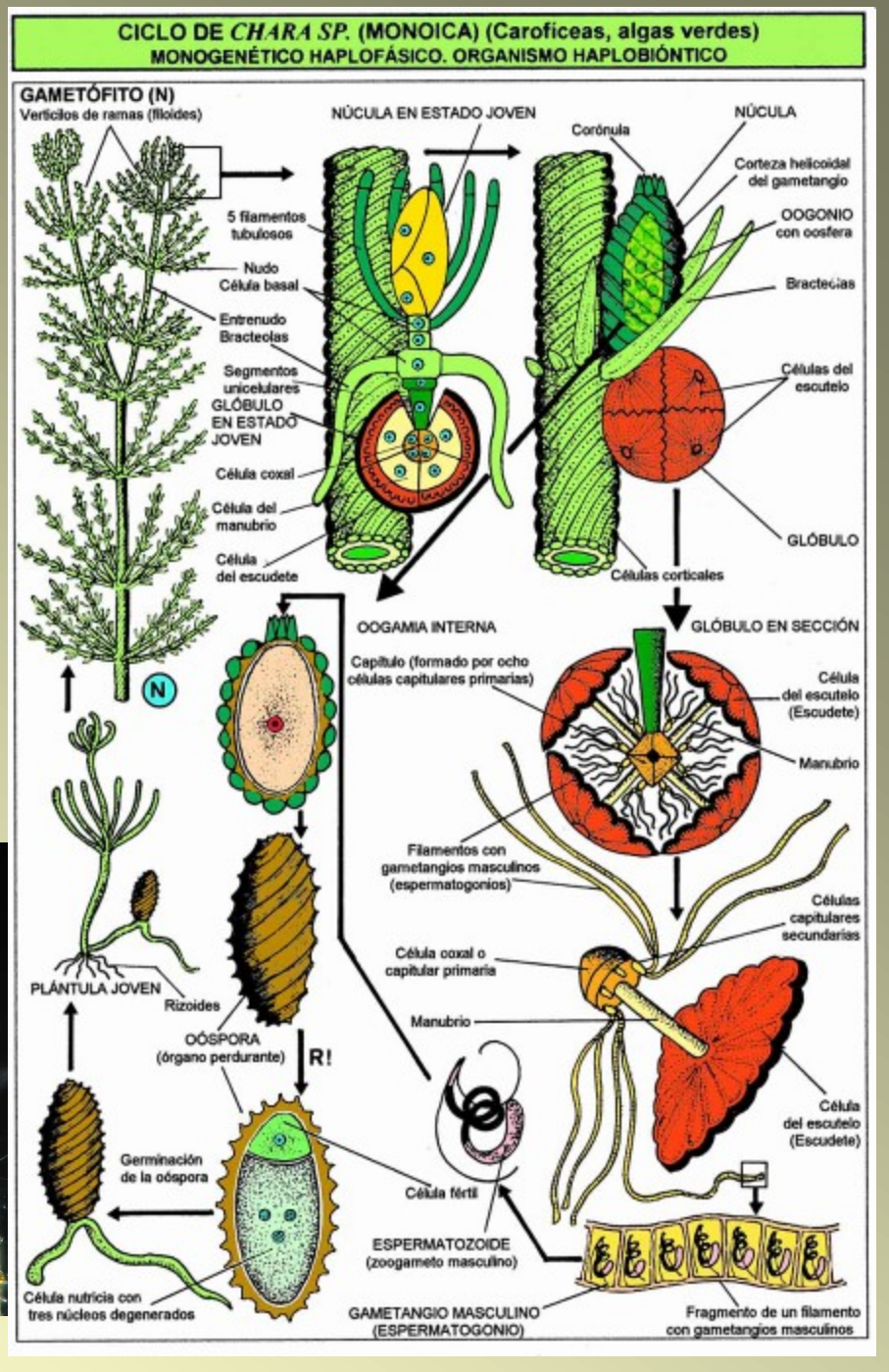
Chara, parožnatka



Chara baltica – Baltské moře

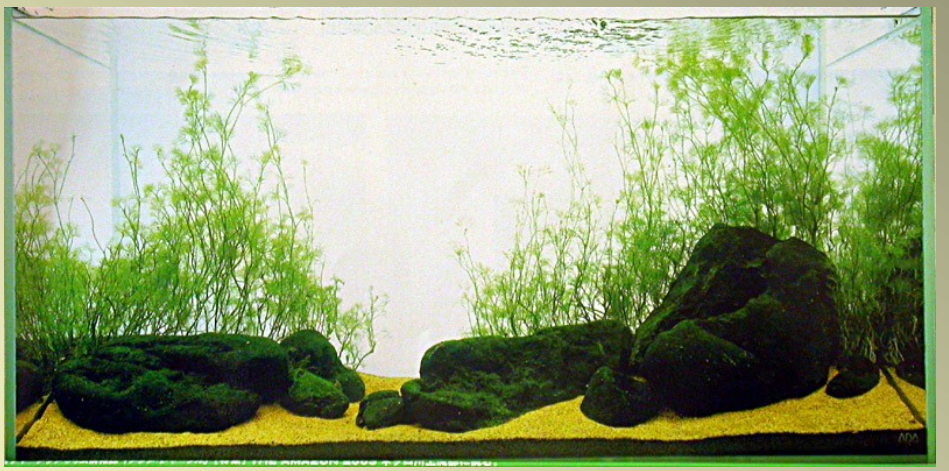
oogonium

antheridium



Plitvická jezera, Chorvatsko

sladkovodní akvária

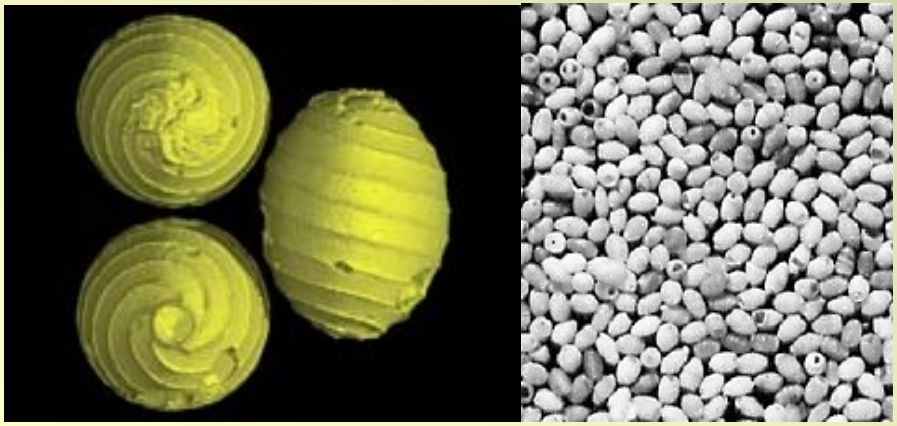


pískovny a lomy

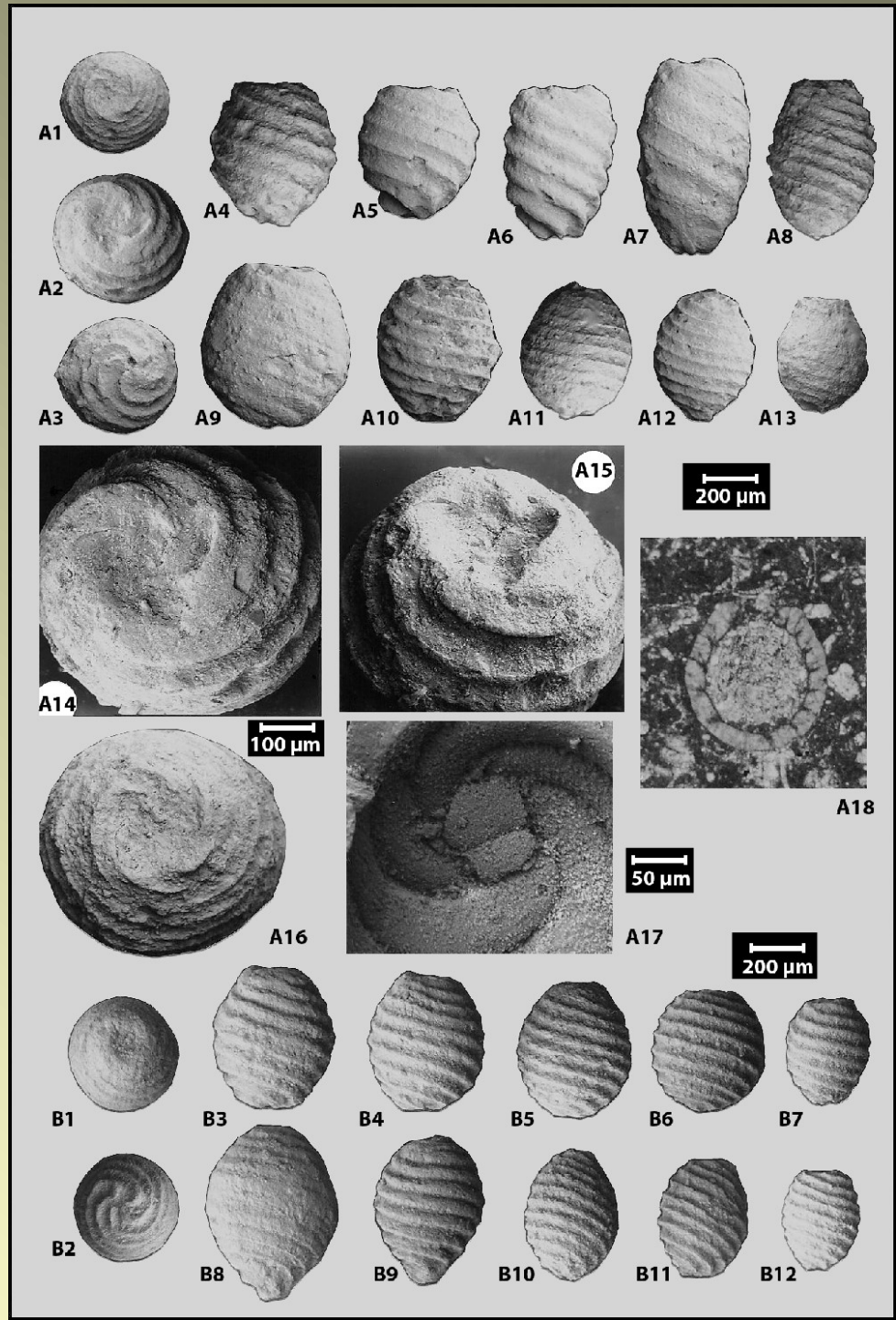

Jihočeské rybníky 6.5.2023

Fosilní gyrogonity

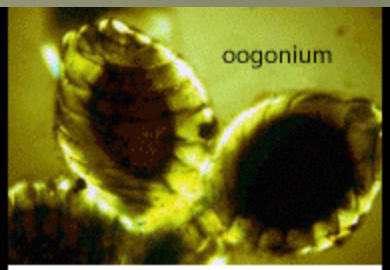
známe-li ekologická data pro žijící druhy, můžeme odhadnout paleoekologické podmínky (hloubku, teplotu, salinitu) dávných jezer, máme-li k dispozici pouze gyrogonity (=fosilizované zygospory)



součástí jezerních sedimentů 400 mil.



Nitella



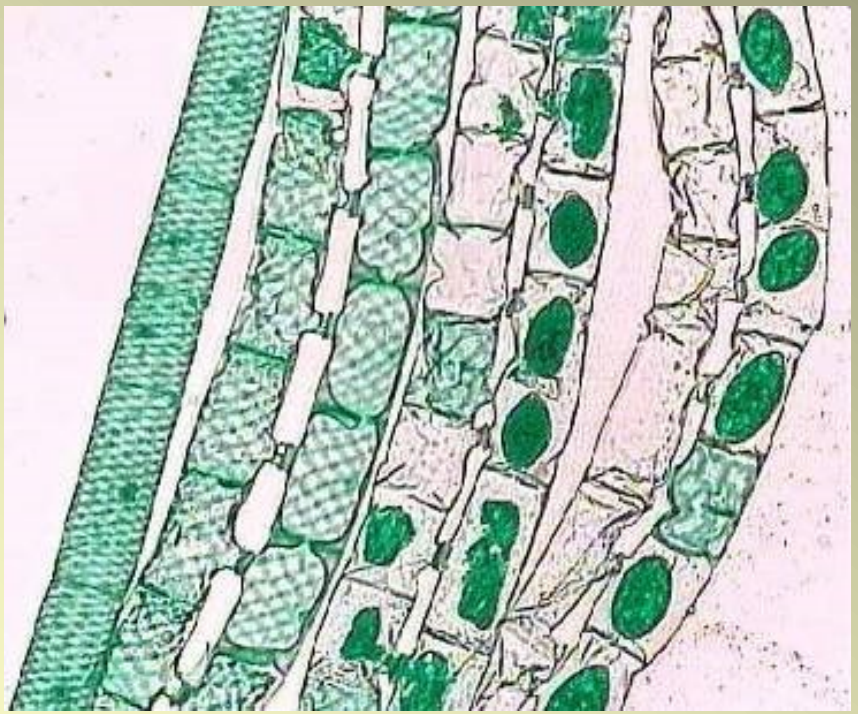
A after Entwisle et al. (1997), B after Prescott (1951)
, see http://www.kranswieren.nl/

Fosilní parožnatky tvorba travertinů

Vyšné Ružbachy

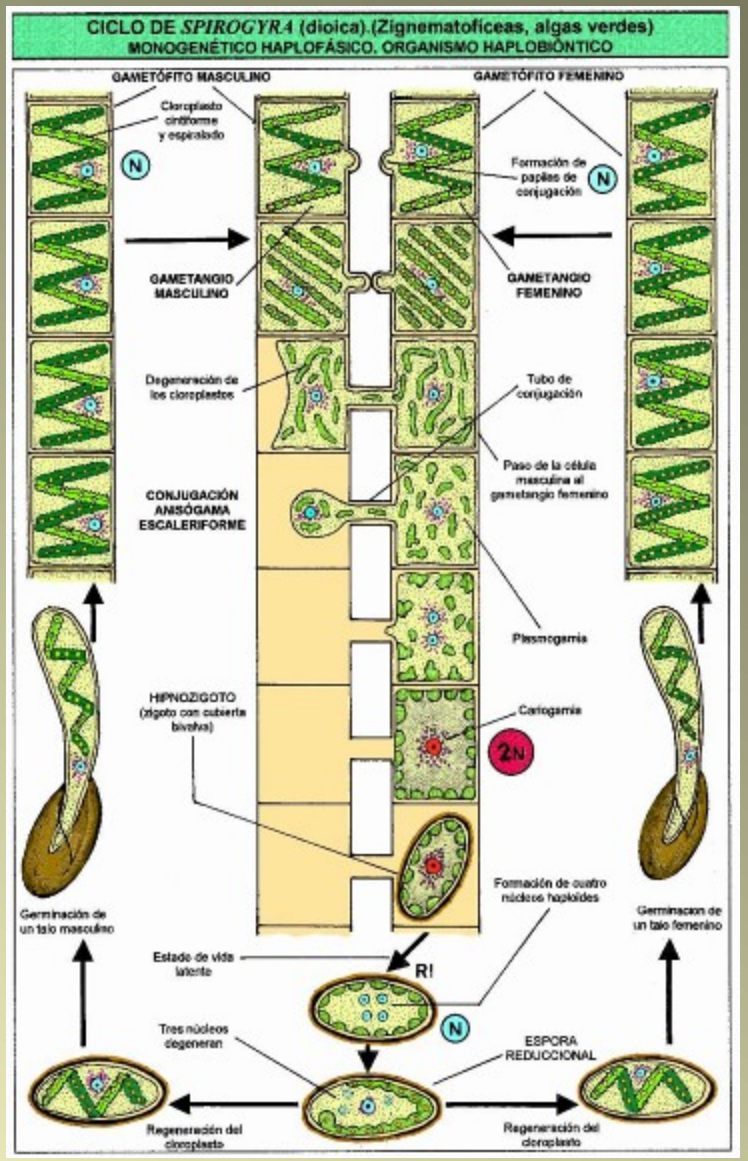
zvápenatělé stélky char se podílely na vzniku minerálu travertinu.

Třída: *Zygnematophyceae*



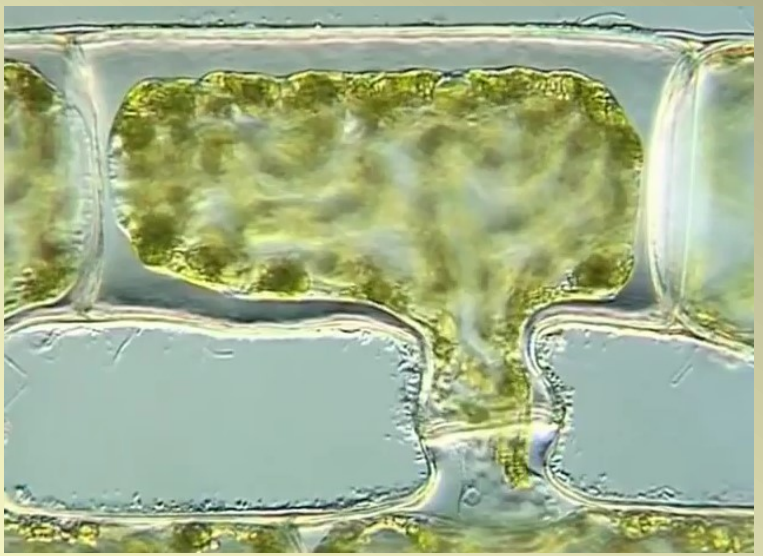
spájení - unikátní způsob pohlavního rozmn.
nejstarší zygospory – Karbon 350 myr

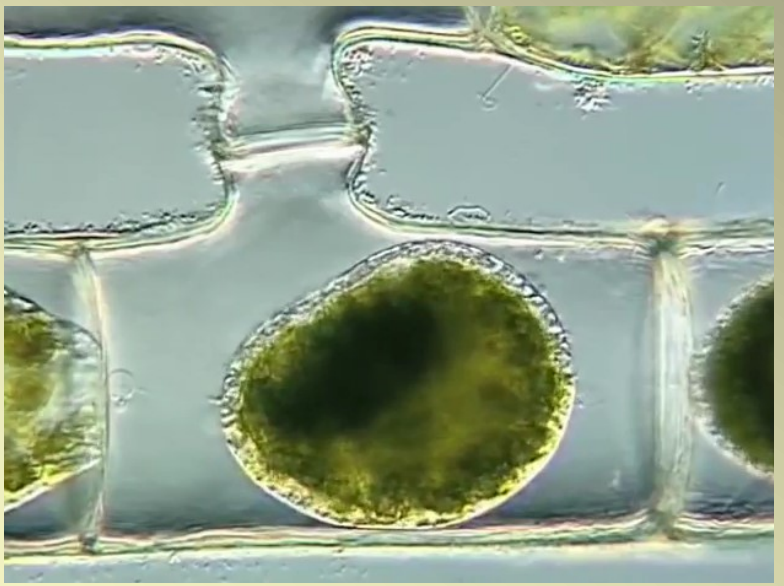
průměrná buňka vyprodukuje 3μg slizu za měsíc



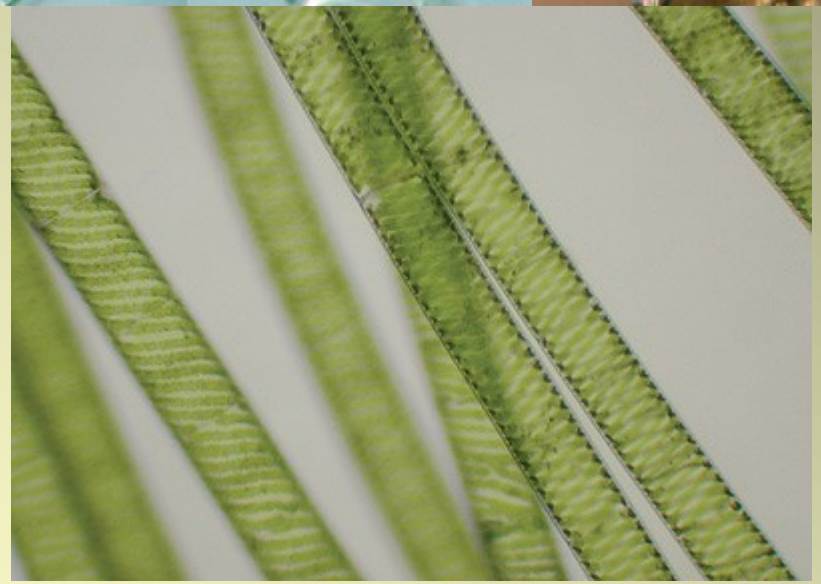
slizové obaly, algenany

https://www.youtube.com/watch?v=DGuwDBdU4JM&ebc=ANyPxKp5_RDuRRHXahur5AsYuzPiPoLbpCOGpe7rCS9pdLS7svbgOJKpHBUfd2V8qAXjFdi_JajOMvw8uh8wPzXBNHnFr1AkrQ

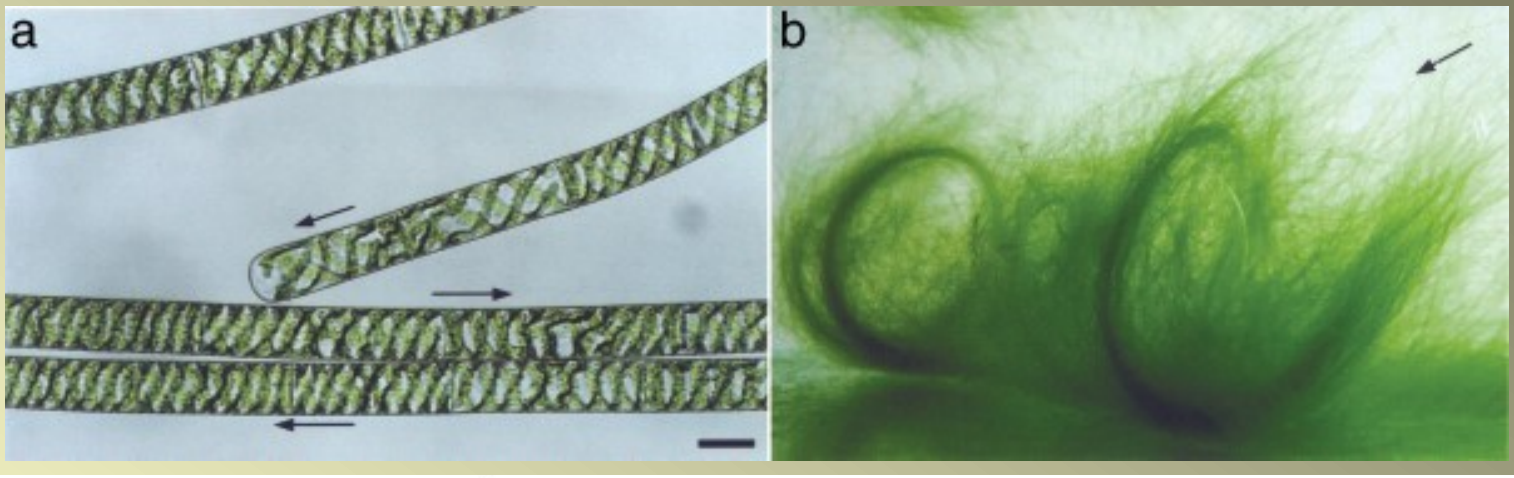


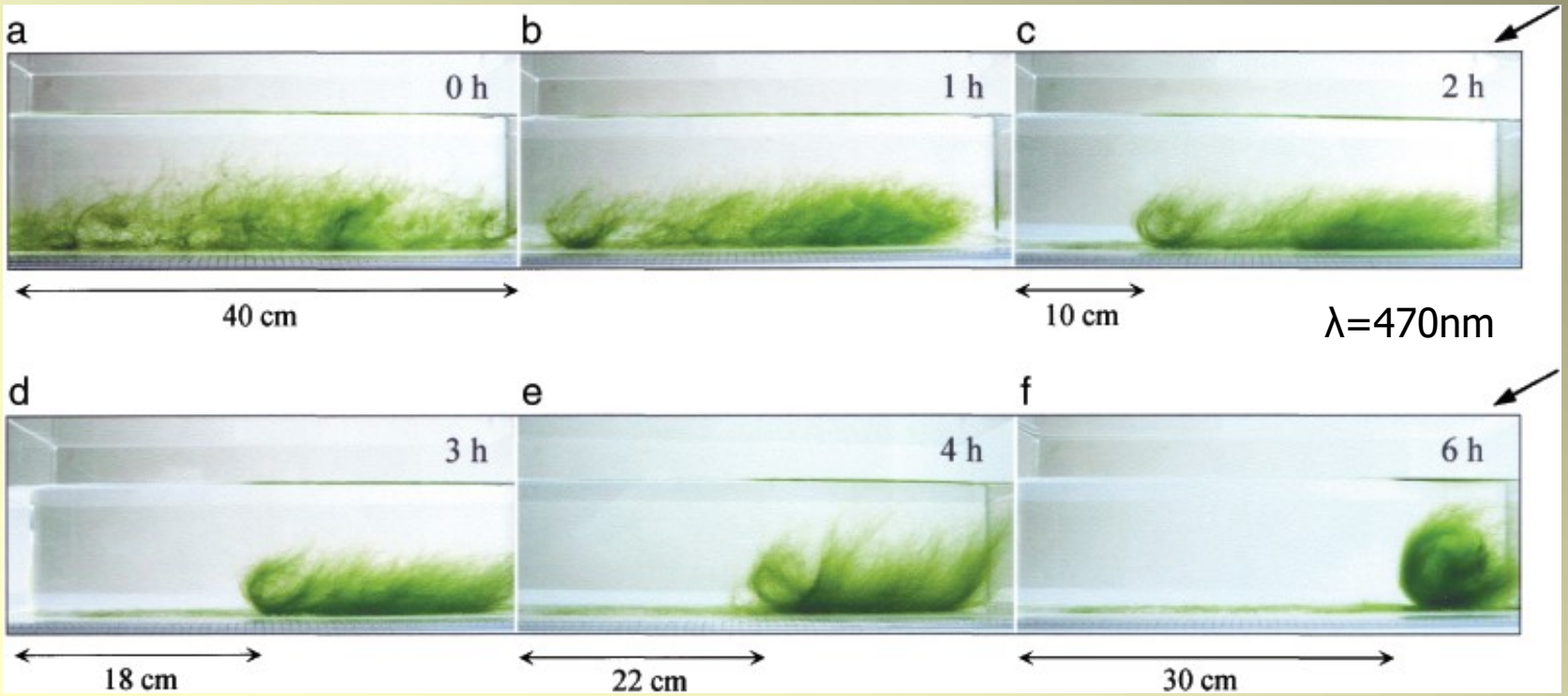


Spirogyra - šroubatka



Pohyb vláken *Spirogyra* ovlivněný světlem

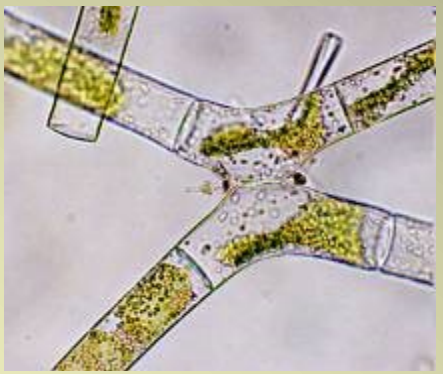


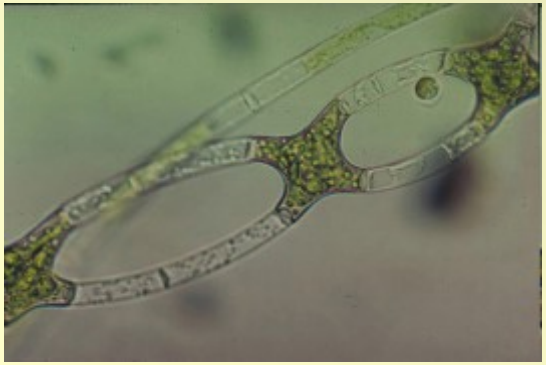


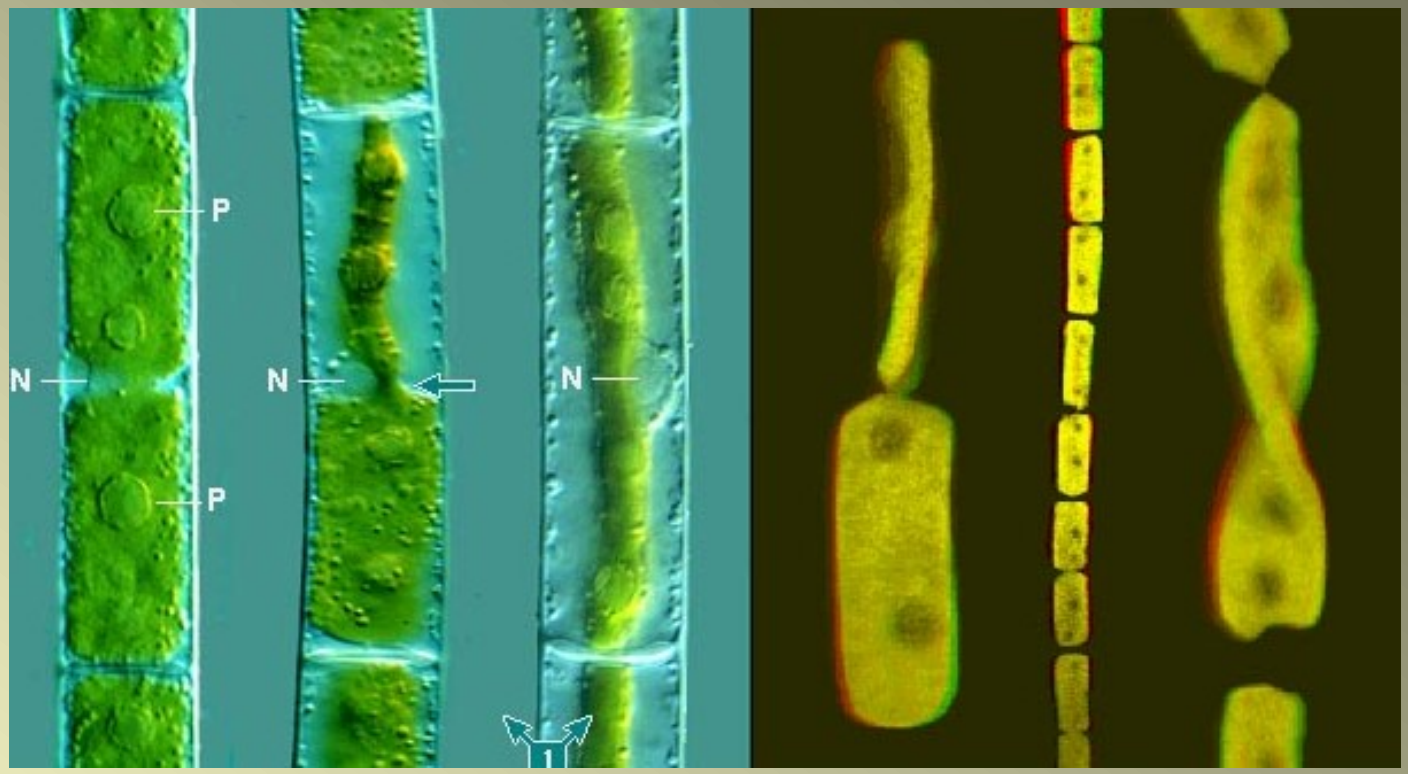
Kim et al. 2004

rychlost pohybu 10 μm/s

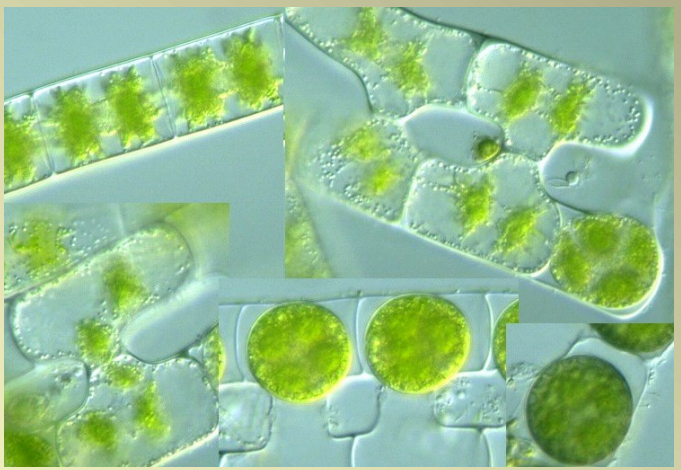
Mougeotia

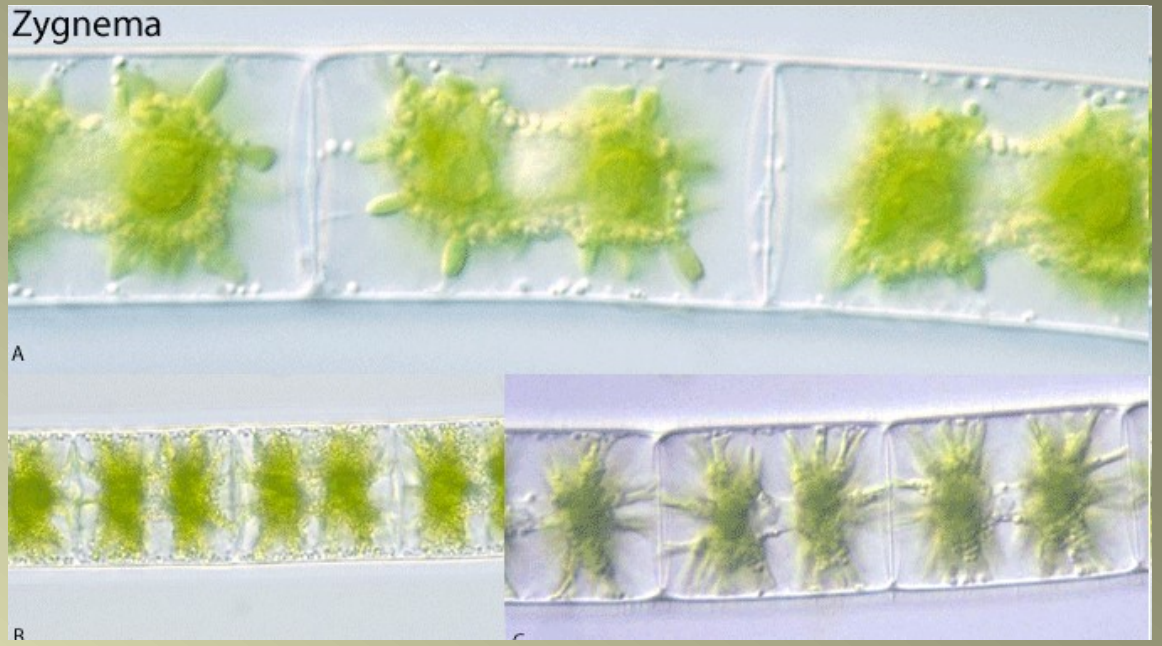






Zygnema - jařmatka

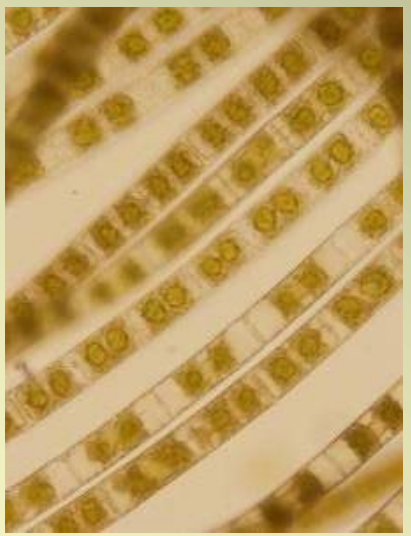




Špicberky – primární producent

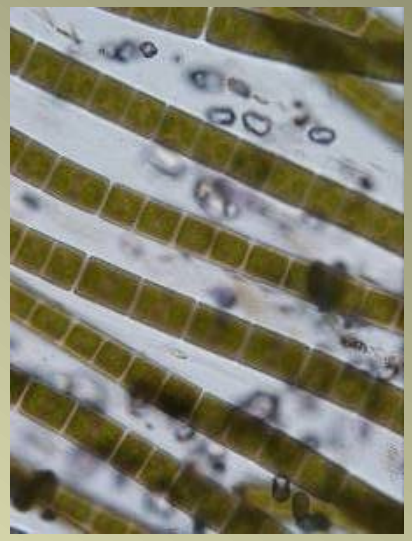
preakinety – modifikované vegetativní buňky - tolerance vyschnutí i zamrznutí

časné léto

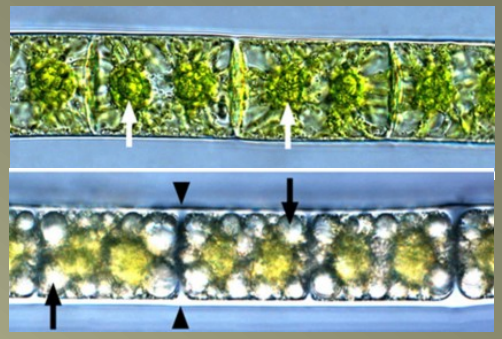


pozdní léto

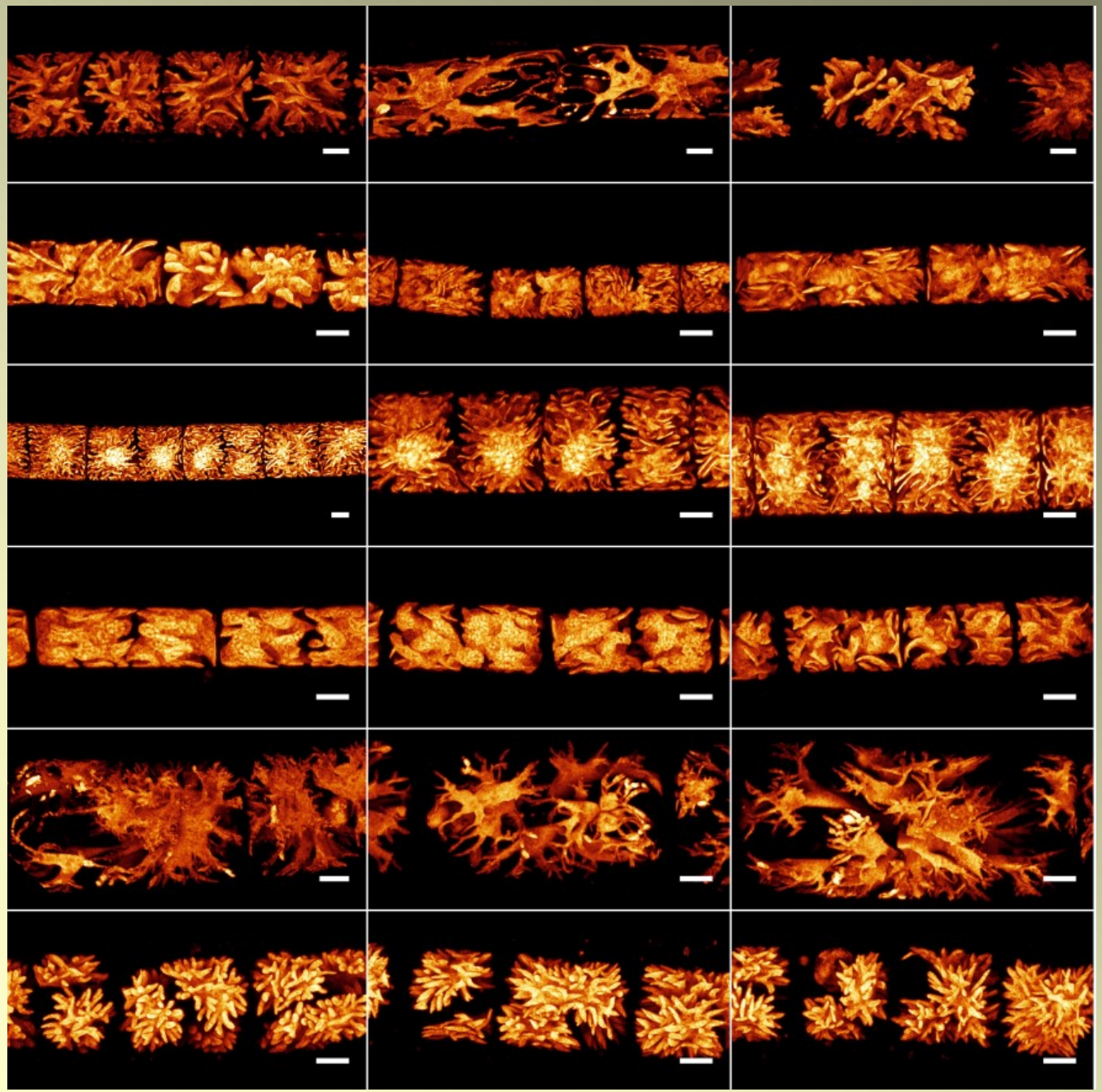
konec zimy



Pichrtová et. al. 2016

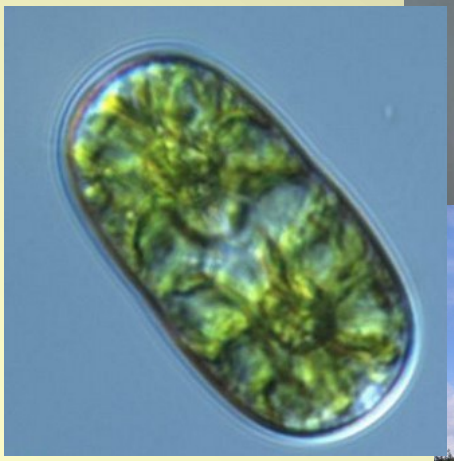


Chloroplasty jednotlivých linií rodu Zygnema



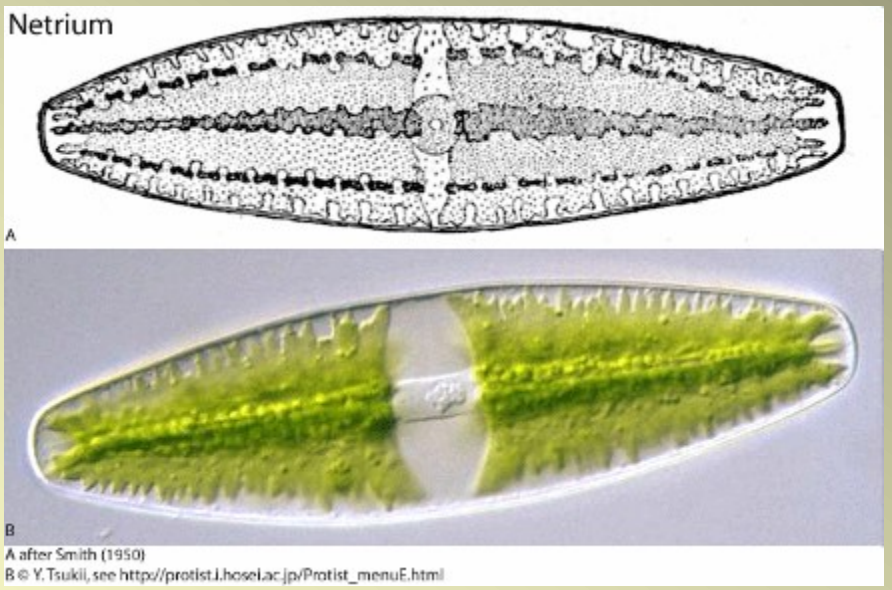
Cylindrocystis

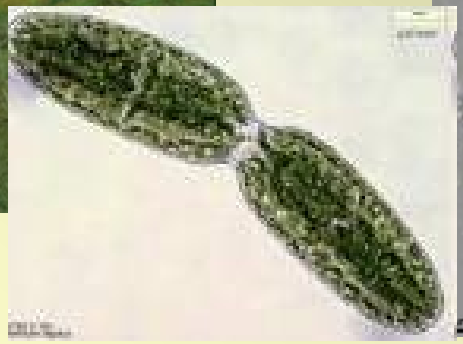
indikátor nízkého pH
biomonotoring



10 µm

Netrium



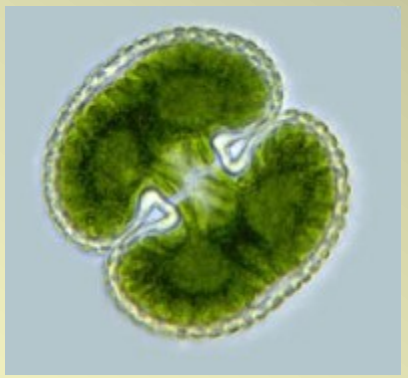


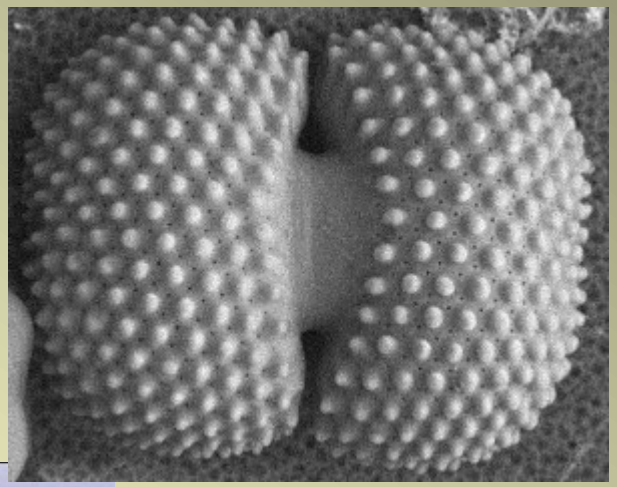
592 chromosómů

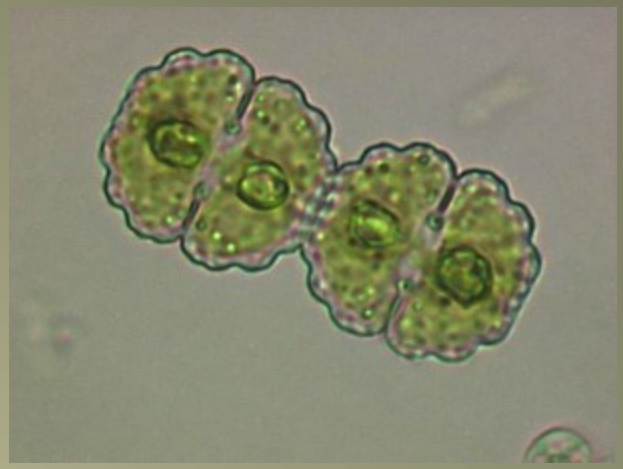
Desmidiales - krásivky

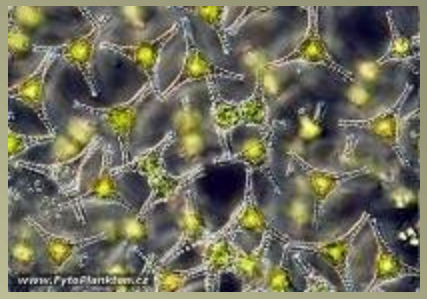
morfologicky definované umělé rody

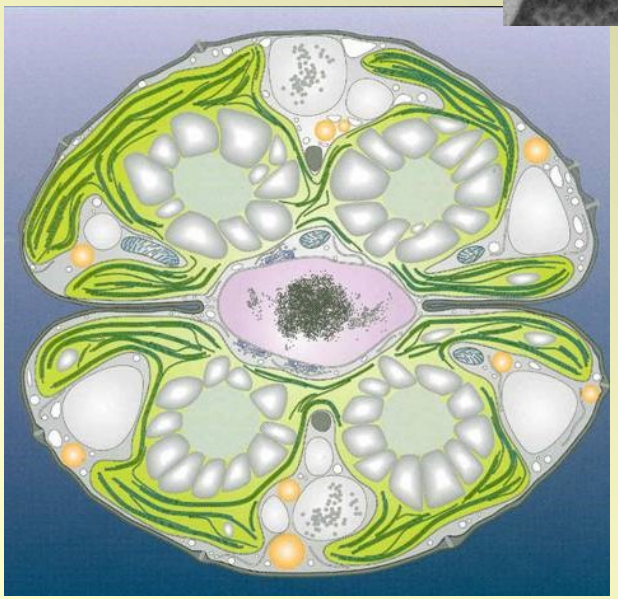
Cosmarium







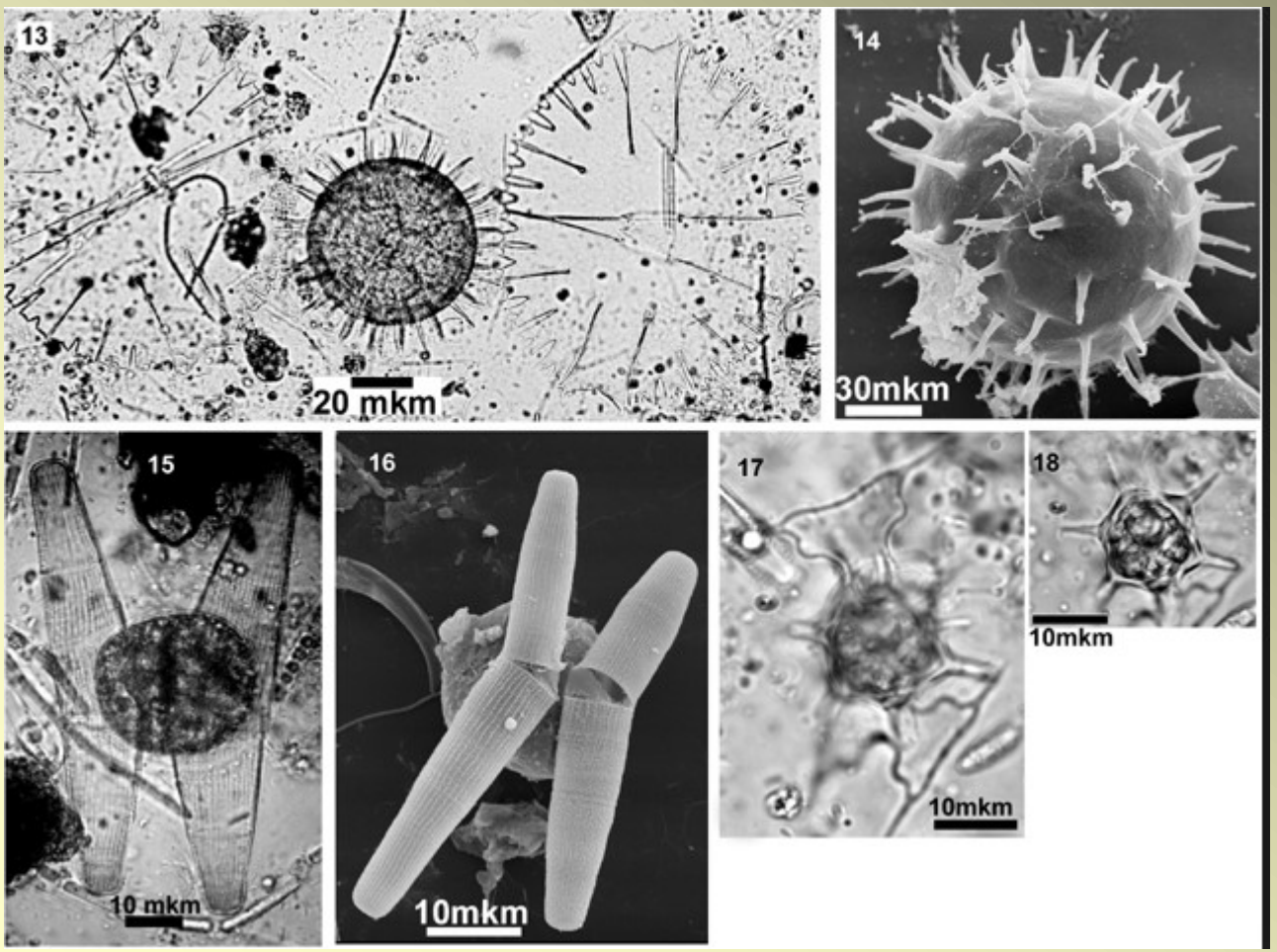




více než 3000 druhů; (většinou) dystrofní biotopy; biomonitoring acidifikace, eutrofizace a klimatických změn; neobyčejně bohatá neadaptivní morfologická radiace

Pohlavní rozmnožování

Micrasterias

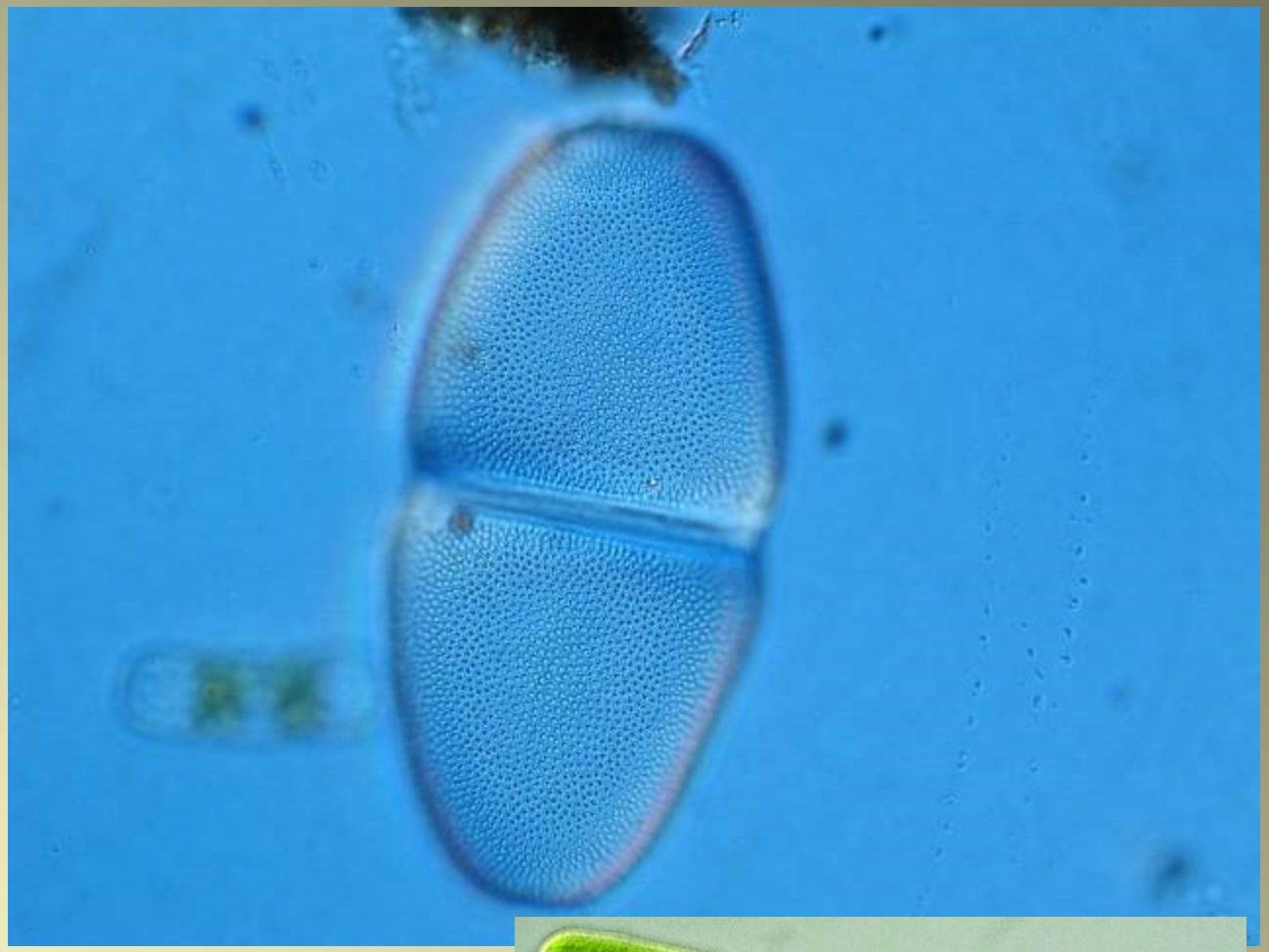


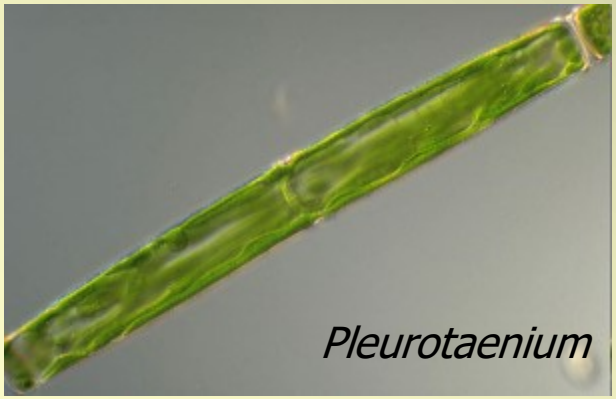
Penium

Staurodesmus

Cosmarium - zygospory

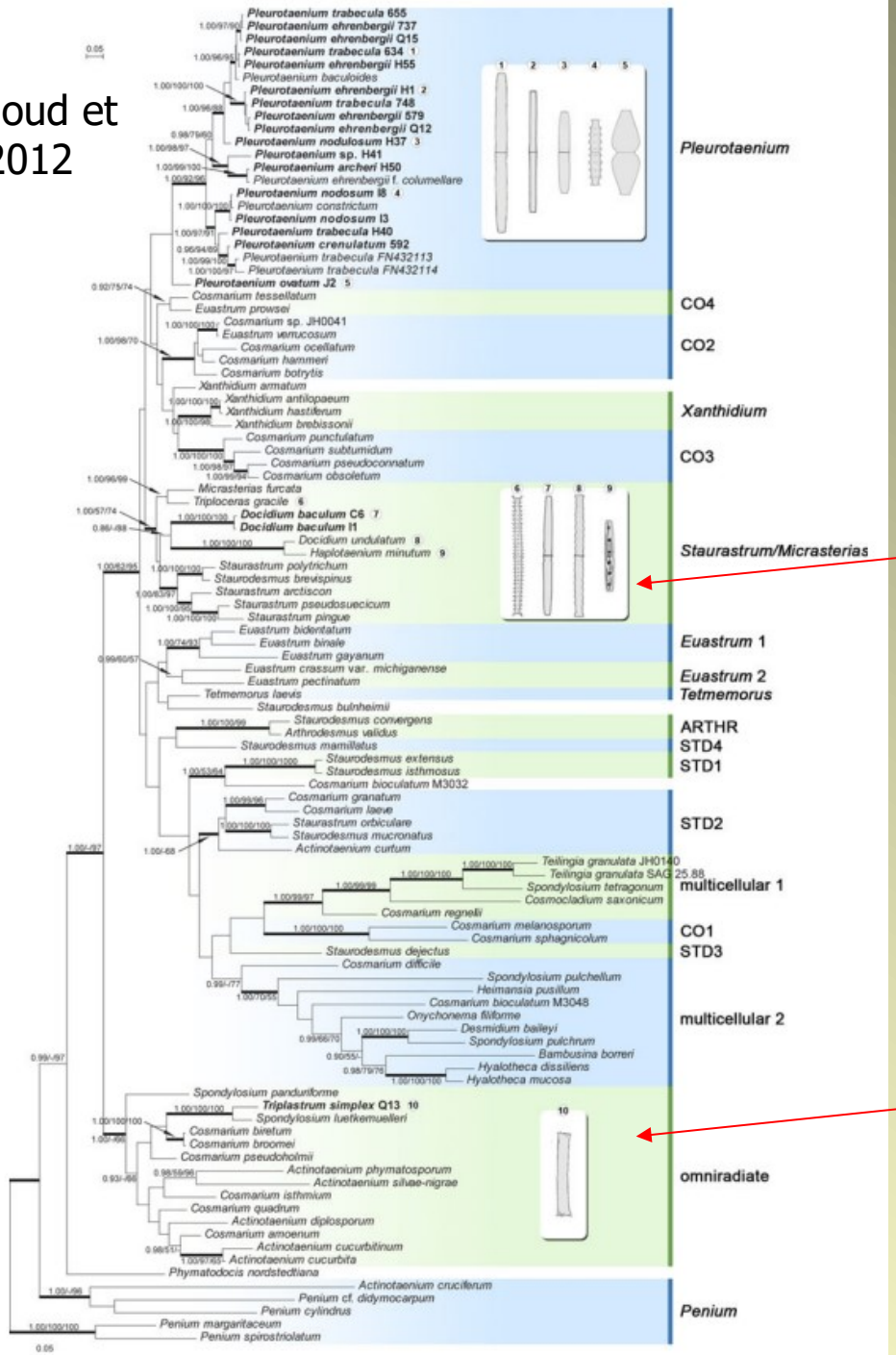
Actinotaenium
Penium
Pleurotaenium

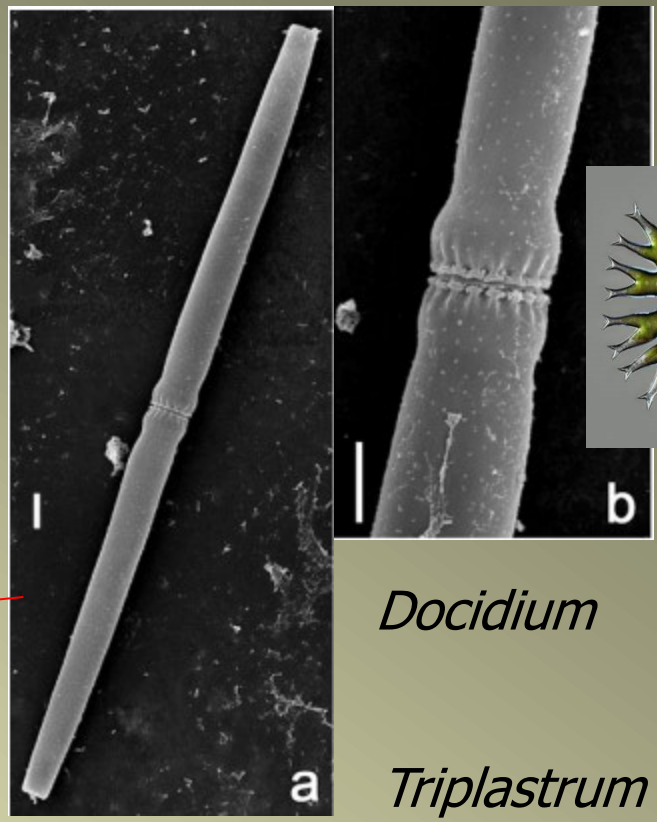




isthmus
semicely

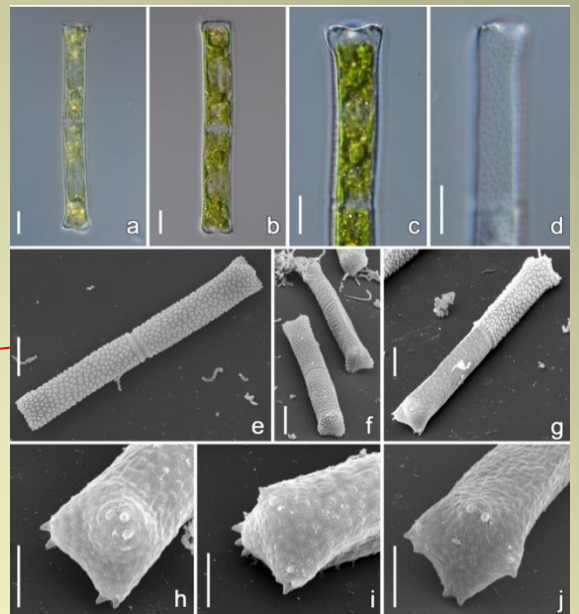
Škaloud et al. 2012



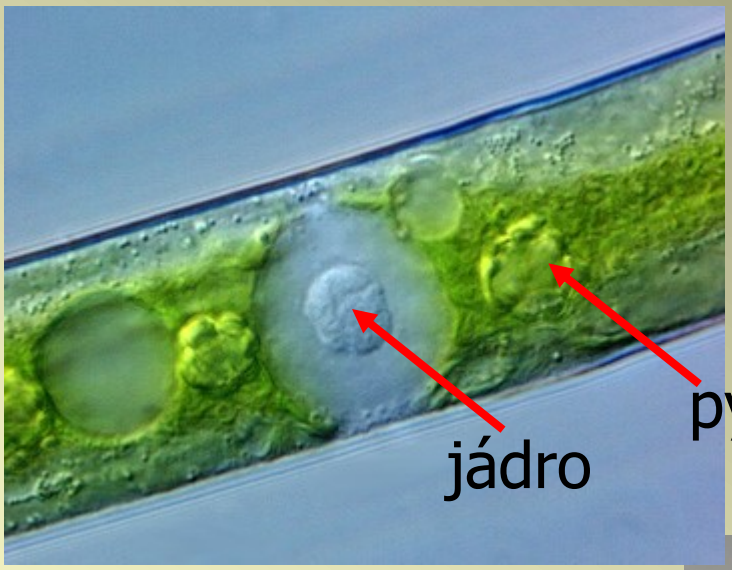


Docidium

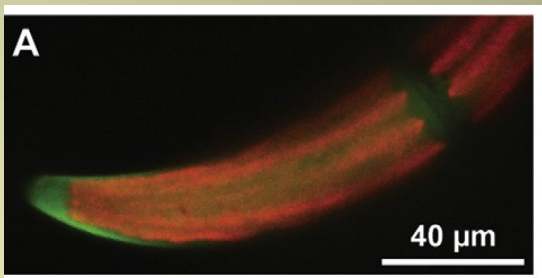
Triplastrum

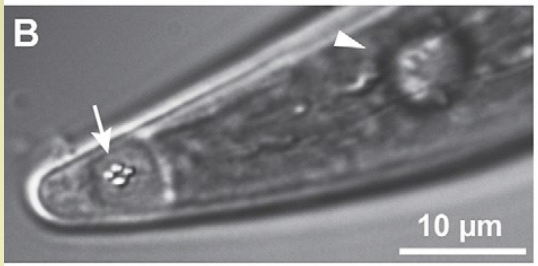


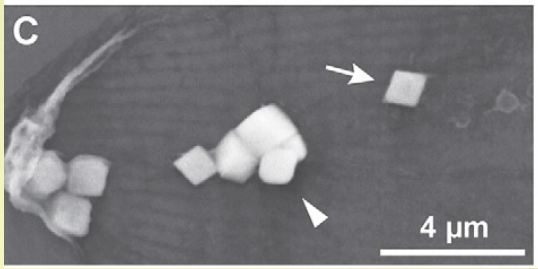
Closterium

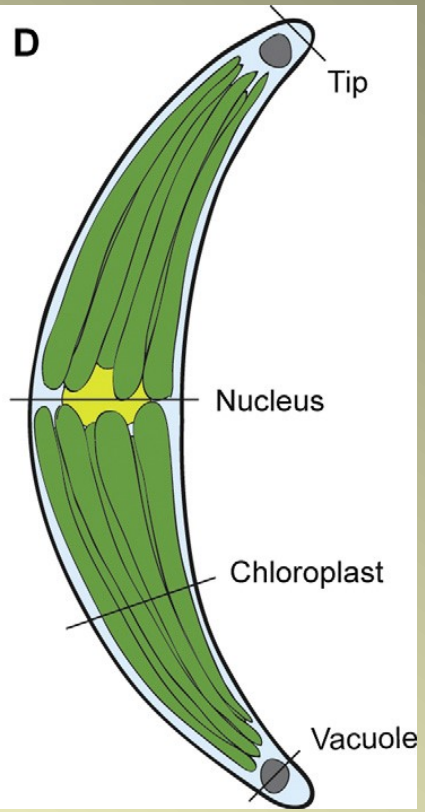


terminální vakuoly obsahují krystaly síranu barnatého

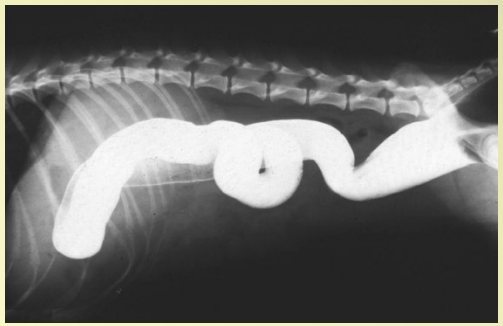


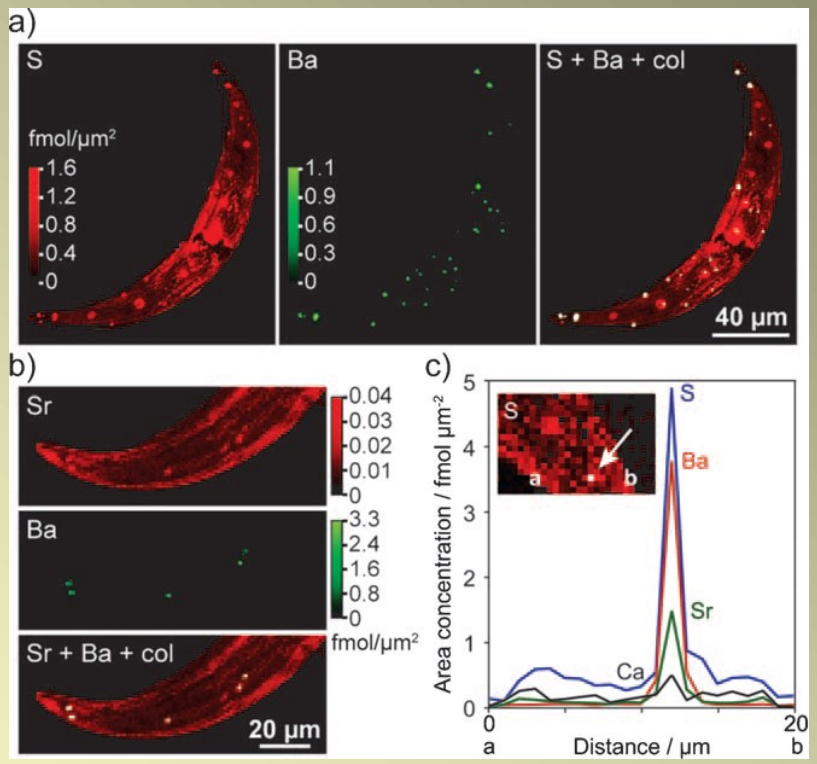






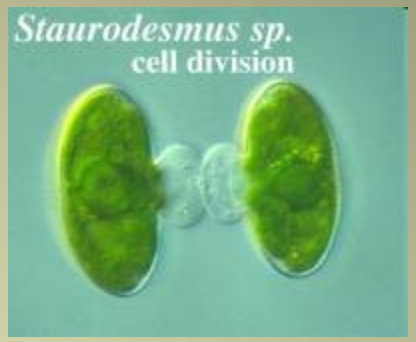
Closterium moniliferum – krystalky síranu barnatého (baritu) – ve vodě nerozpustný, kontrastní látka při rentgenovém vyšetření

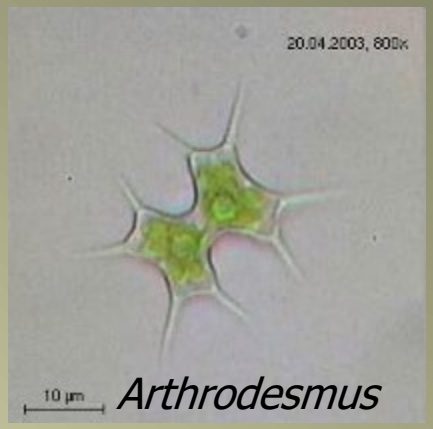


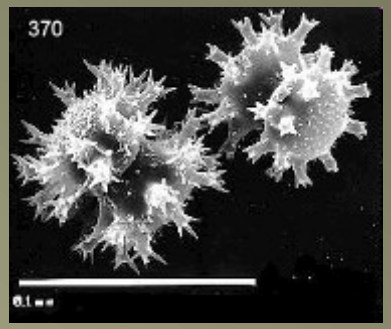


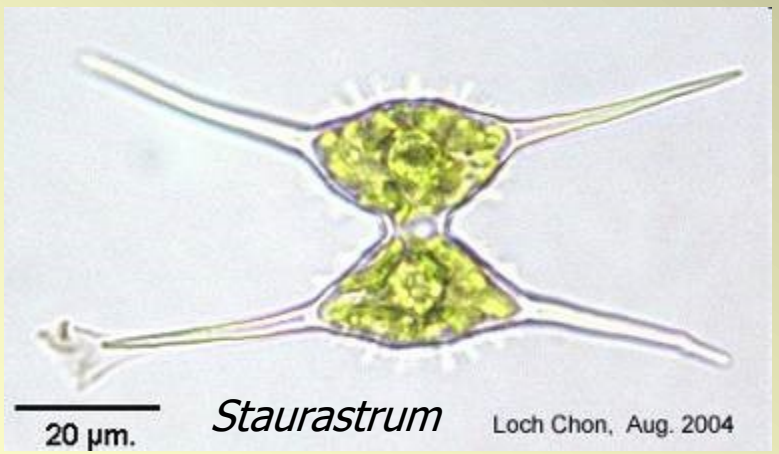
mapa prvkového složení X-ray fluorescence microscopy (XFM)

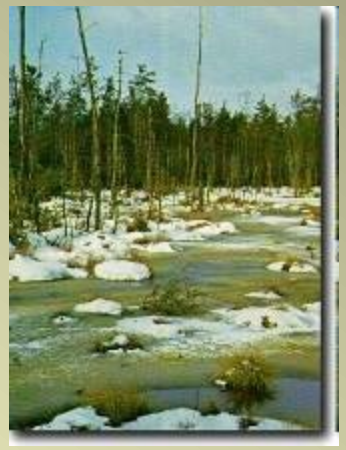
Staurastrum, Xanthidium, Arthrodesmus, Staurodesmus



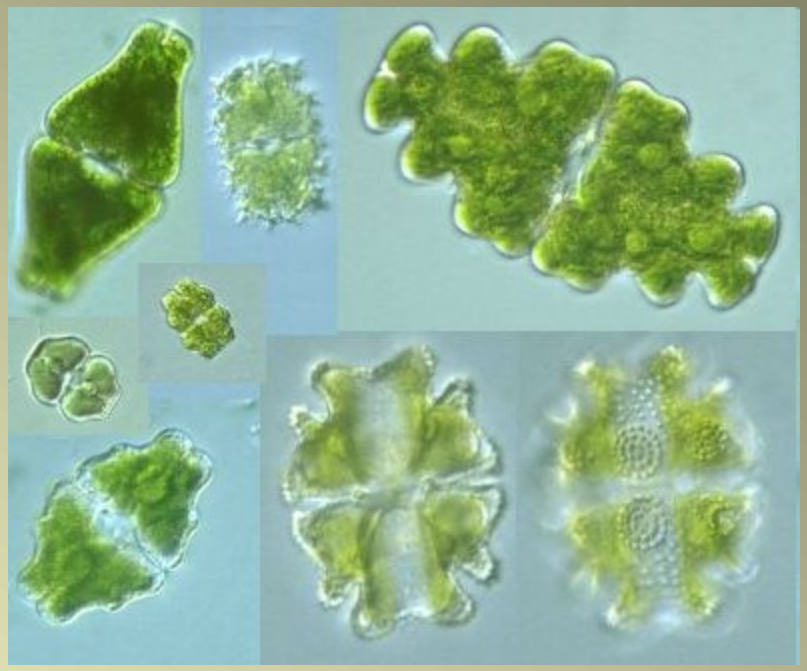


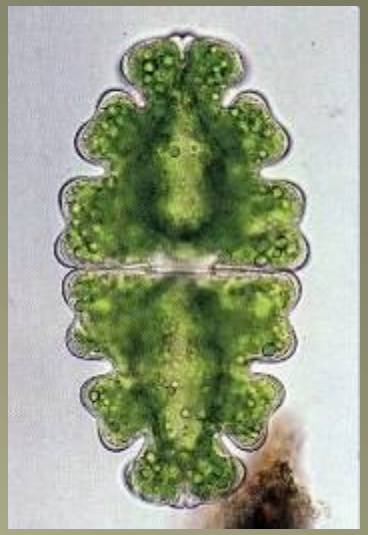


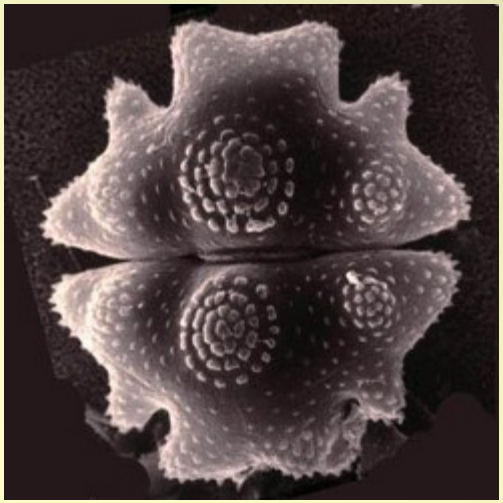


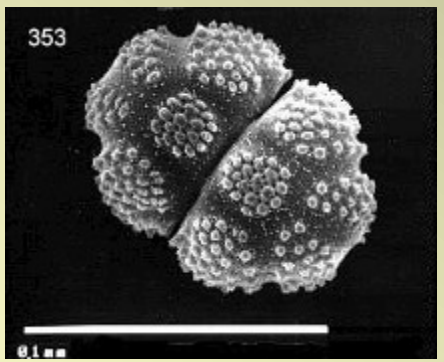


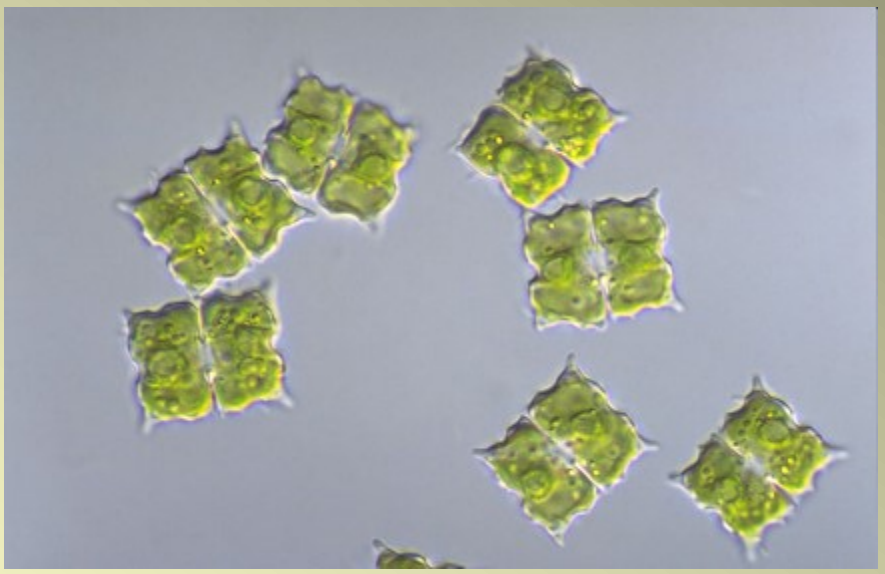
Euastrum











Euastrum division

https://www.youtube.com/watch?v=gzh5j3NJ5-Q

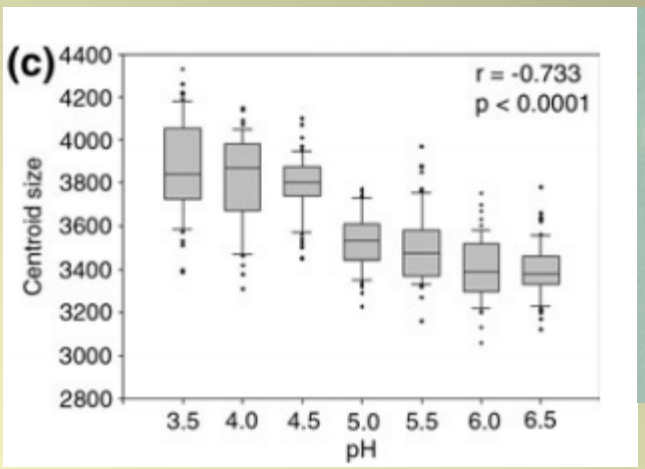
Closterium division

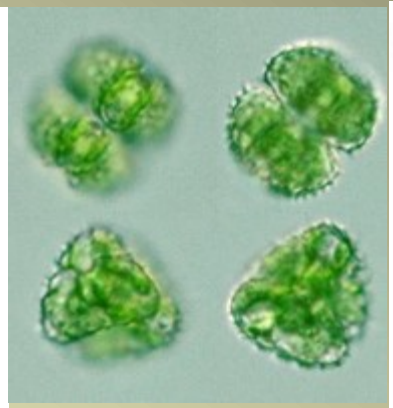
https://www.youtube.com/watch?v=VtuBmXl0ttM

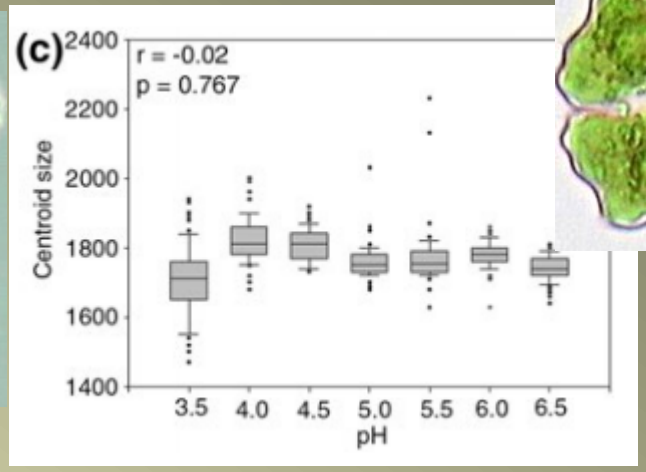
Cytoplasmic Streaming Chara

https://www.youtube.com/watch?v=kud4qUhsCxg

Změna tvaru a velikosti buněk krásivek v gradientu pH

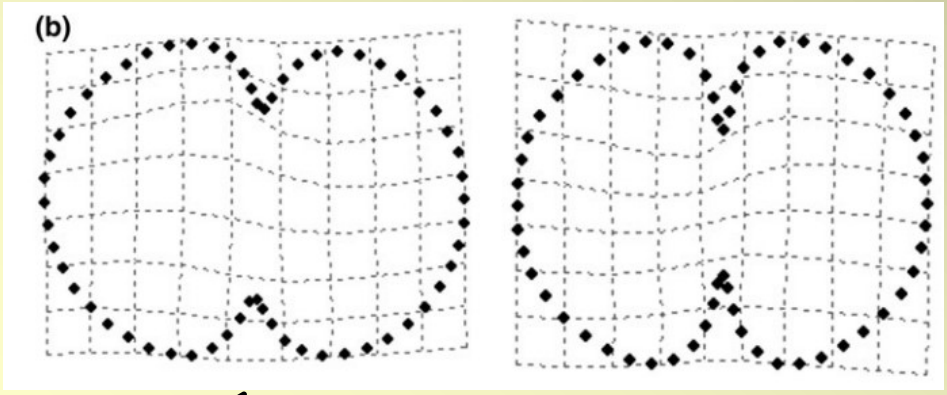


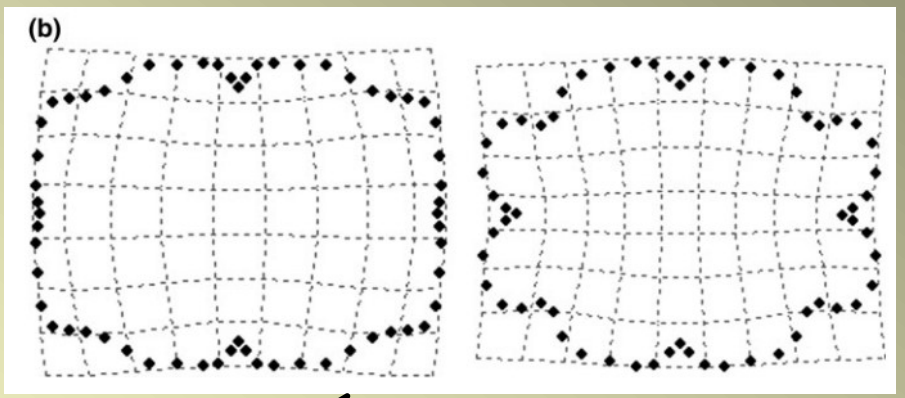




Staurastrum hirsutum

Euastrum binale





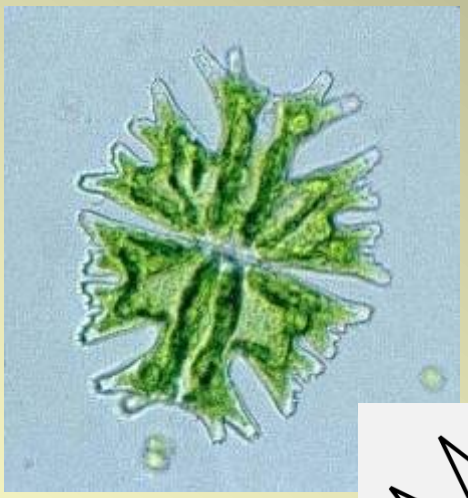
zvětšování buněk

zmenšování komplexity

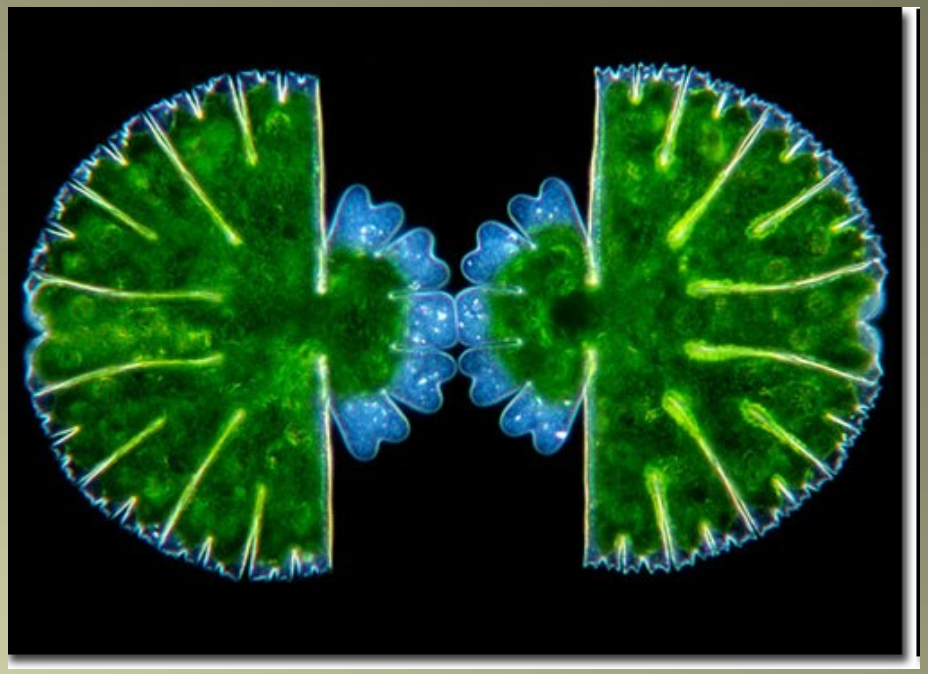
minimalizace P:V v extrémně kyselém prostředí

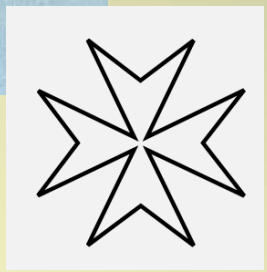
Černá & Neustupa (2010)

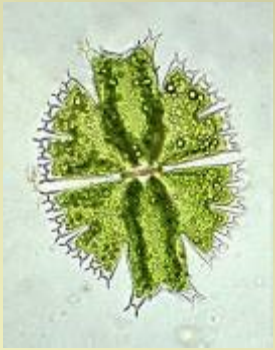
Micrasterias

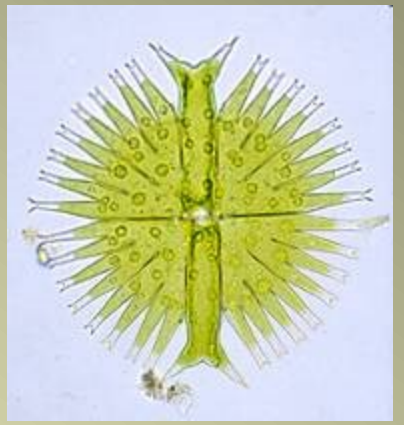


M. crux-melitensis

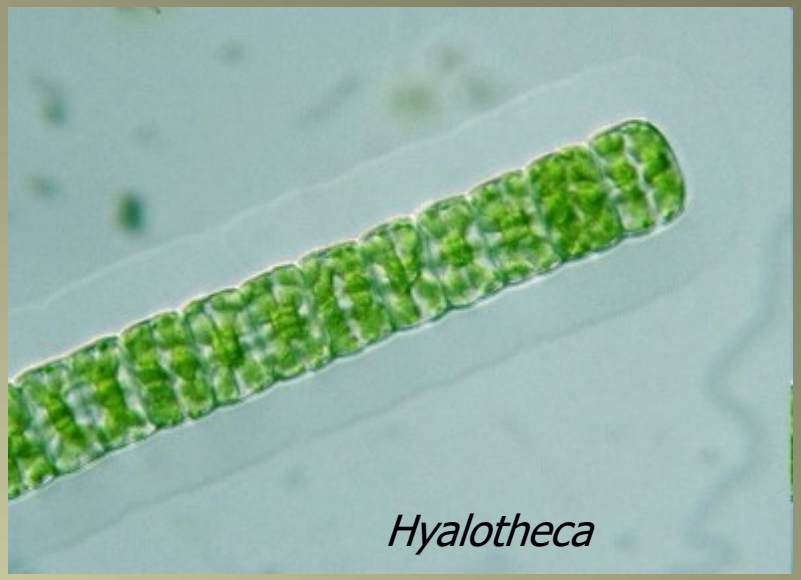




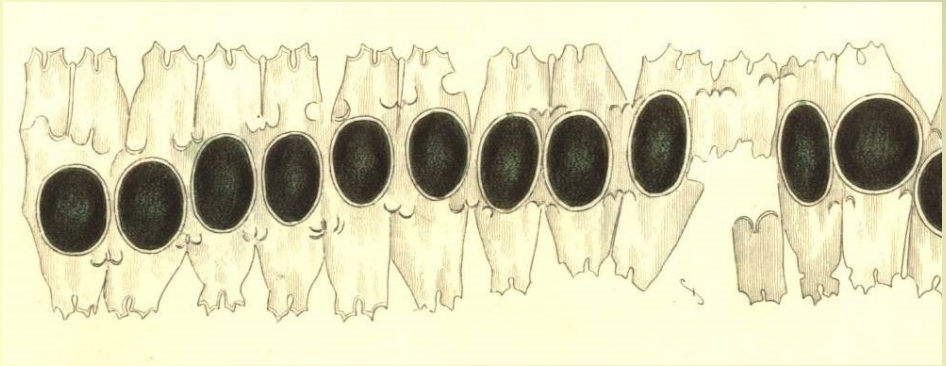




Desmidium, Hyalotheca



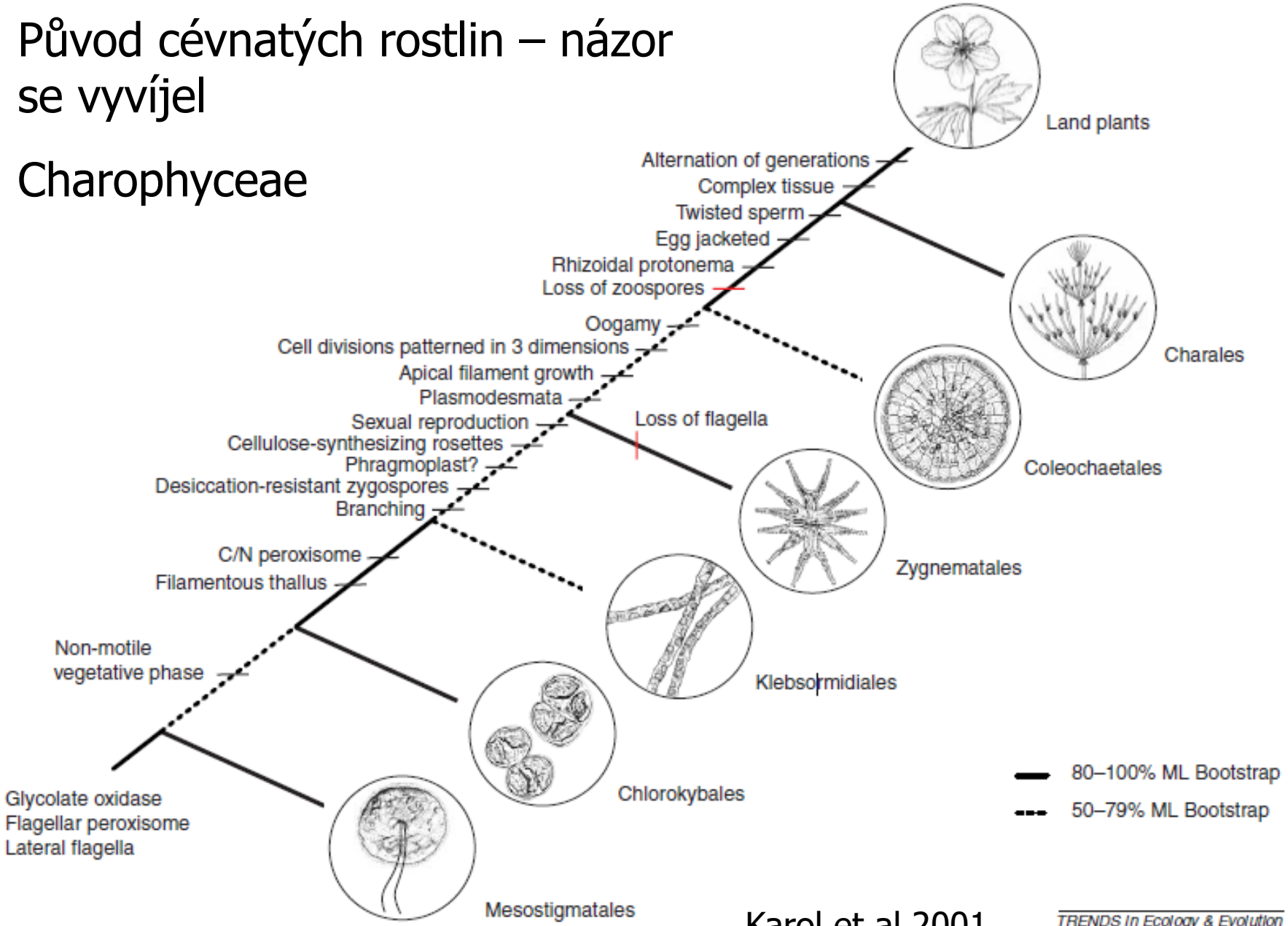
mesotrofní rašeliniště



horská rašeliniště

Původ cévnatých rostlin – názor se vyvíjel

Charophyceae



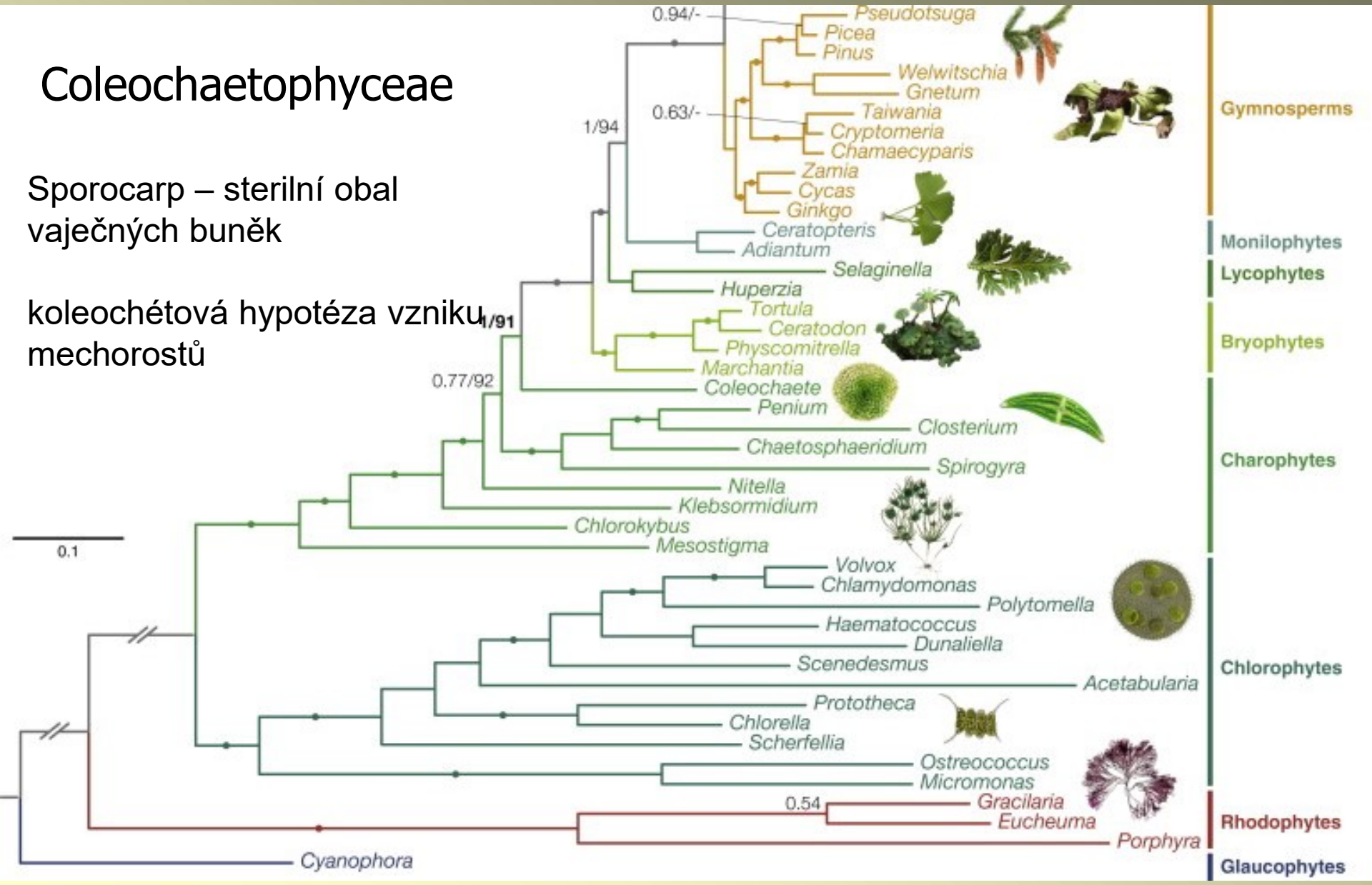
Karol et al.2001

TRENDS In Ecology & Evolution

Coleochaetophyceae

Sporocarp – sterilní obal vaječných buněk

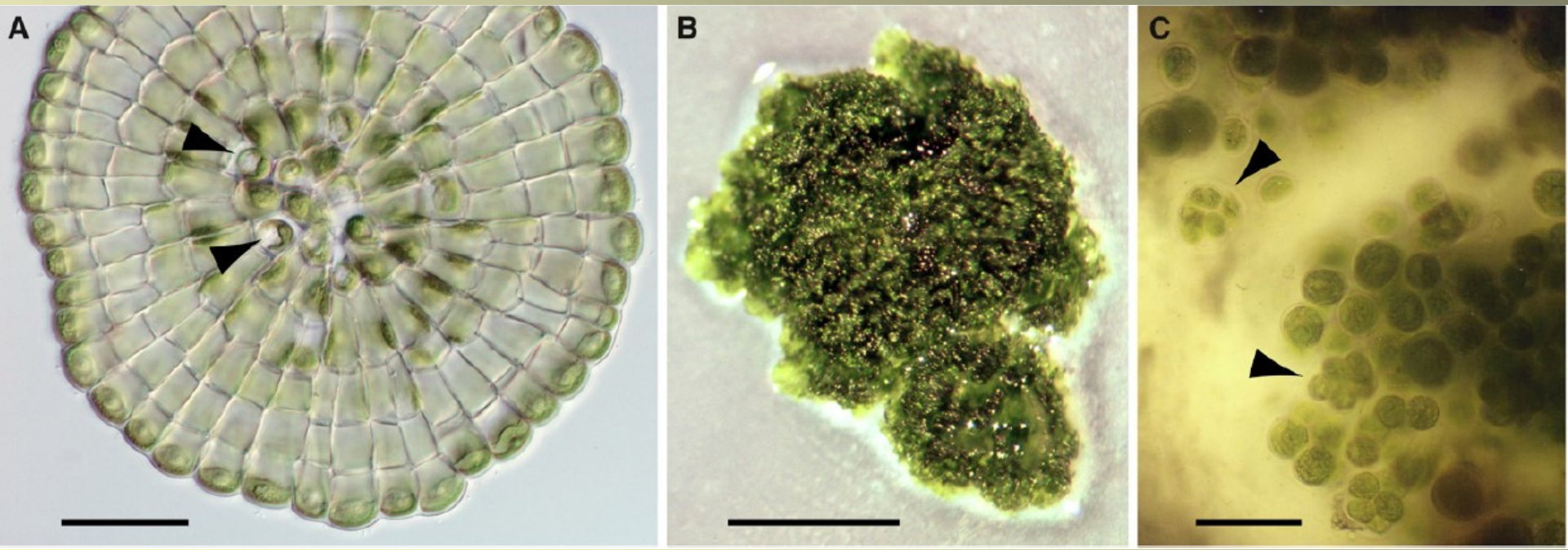
koleochétová hypotéza vzniku mechorostů



Finet at al. 2010

77 jaderných genů, 70 druhů

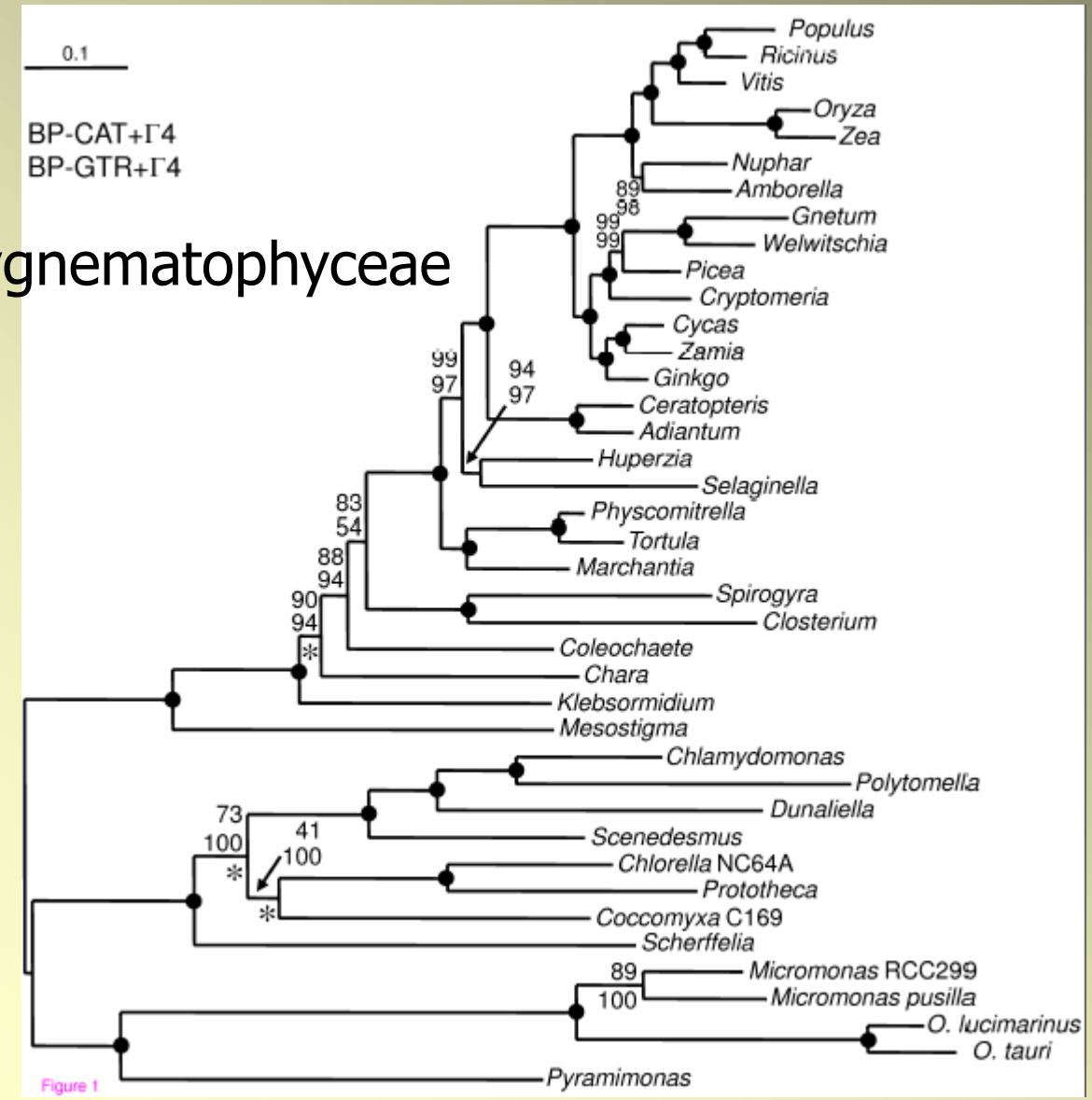
Přežila by vodní Coleochaete přechod na souš?



Morfologie *Coleochaete orbicularis* rostoucí ve vodním (A) a aeroterestrickém prostředí (B, C)

Graham et al. 2012

Origin of land plants: Do conjugating green algae hold the key?



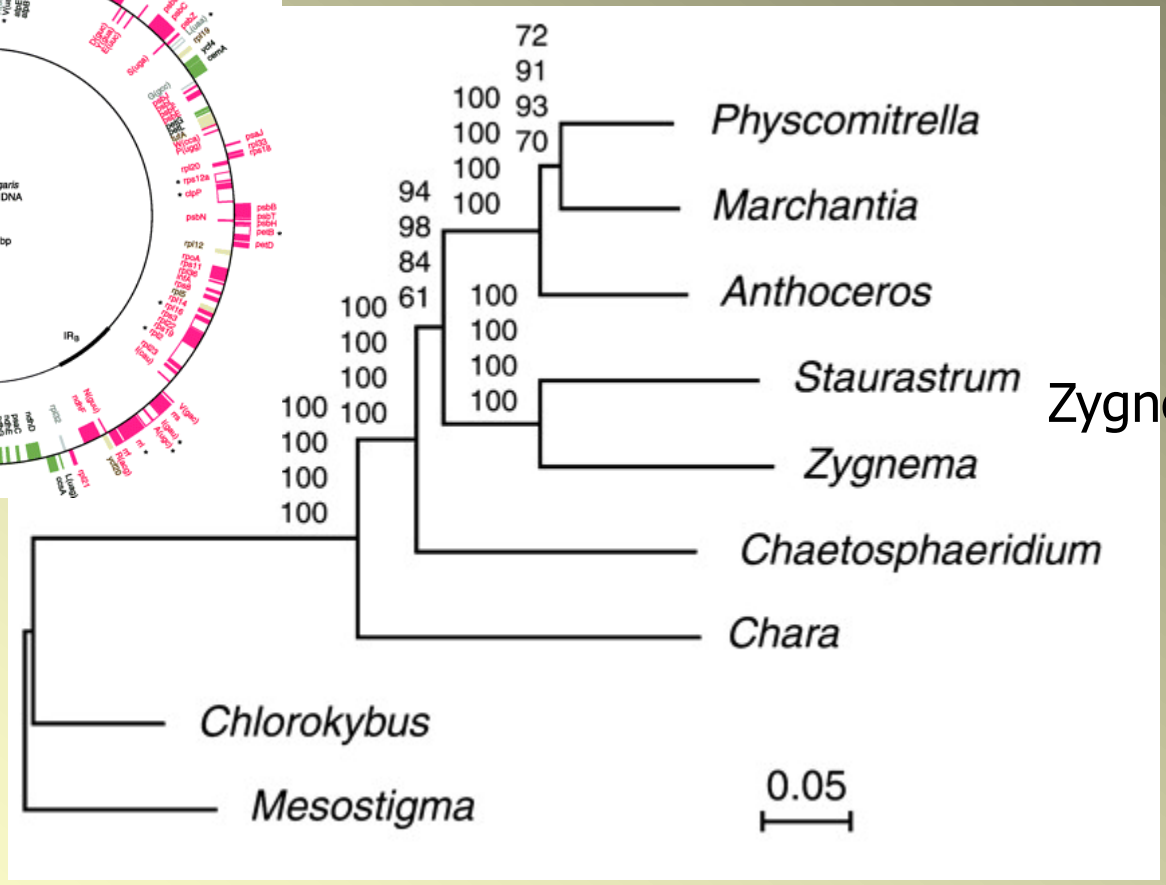
Zygnematophyceae

Figure 1 - Consensus Tree inferred by PhyloBayes under the CAT+ Γ4 using the viridiplant data set of 40 taxa and 30,270 amino acid positions (129 concatenated nuclear encoded proteins).

Vodniok et al. 2011 BMC

sekundární simplifikace

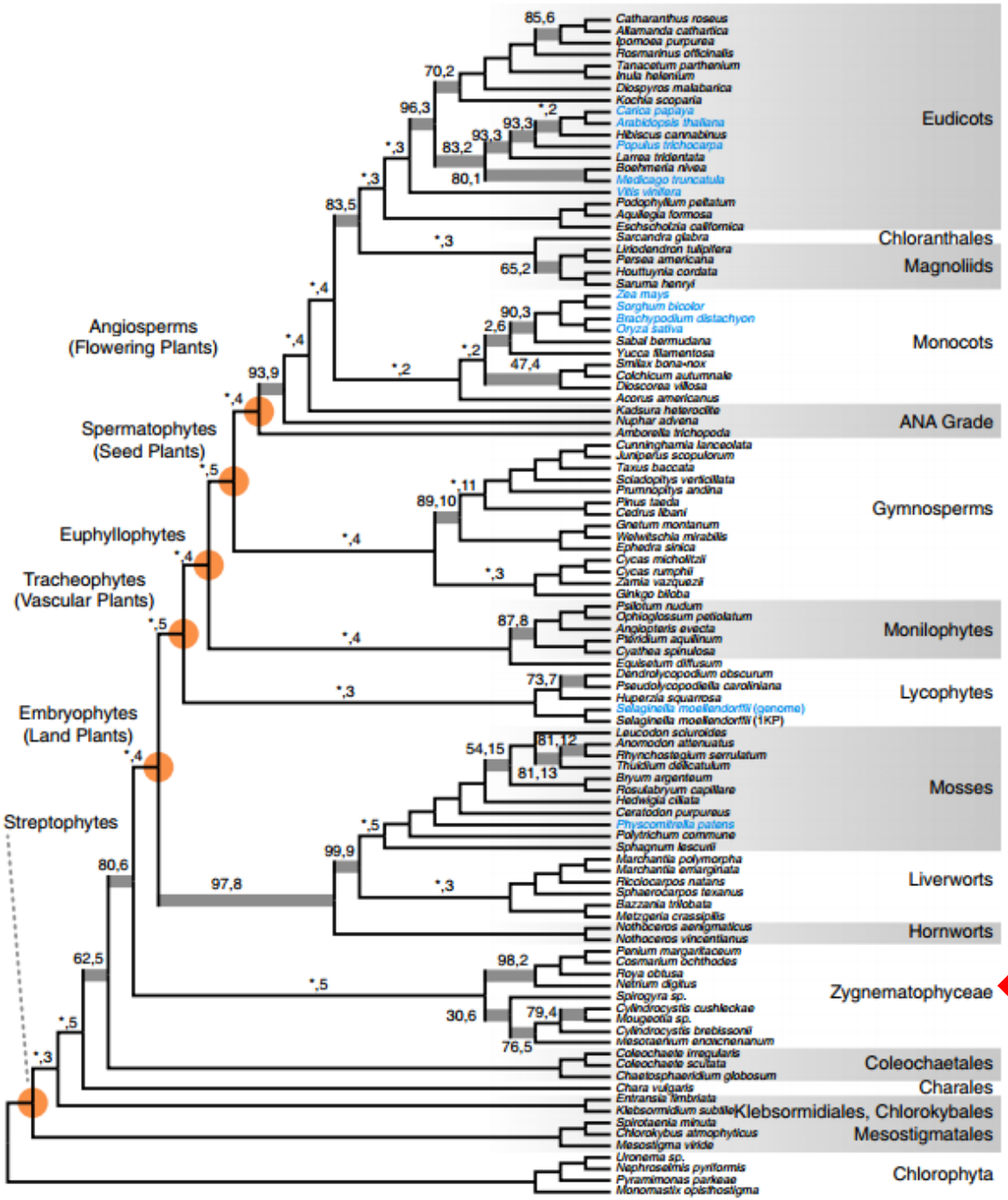
Phylogenies inferred from 76 chloroplast protein-coding genes and their deduced amino acid sequences.



Zygnematophyceae

Turmel M et al. Mol Biol Evol 2006;23:1324-1338

MBE MOLECULAR BIOLOGY AND EVOLUTION

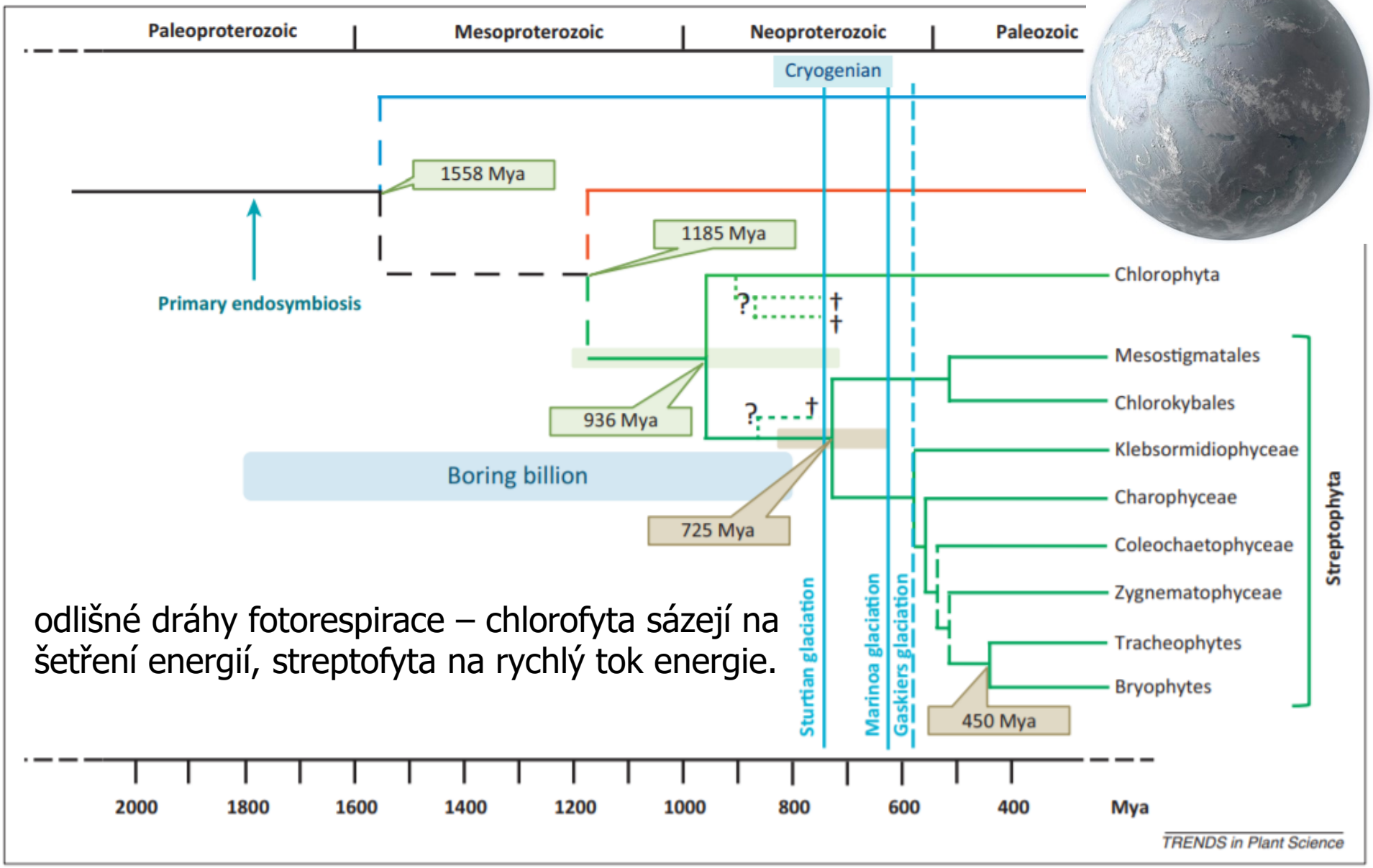


Wickett et al. 2014 PNAS

Transkriptomická analýza původu a časné diversifikace cévnatých rostlin

Our results are consistent with recent, algae-centric analyses that report Zygnematophyceae as sister to land plants

Becker 2013



odlišné dráhy fotorespirace – chlorofyta sázejí na šetření energií, streptofyta na rychlý tok energie.

Hypotéza: oddělení Chlorophyta/Streptophyta souvisí se „snowball Earth" v Neoproterozoiku (sturtovské zalednění 717-660 Ma), pokles CO_2

Planktomania

https://www.youtube.com/watch?v=8dPG16sRPLQ

https://planktomania.org/cs/

https://www.youtube.com/watch?v=8dPG16sRPLQ

Land Plants Cryogenian Cradle

Žárský et al. 2022