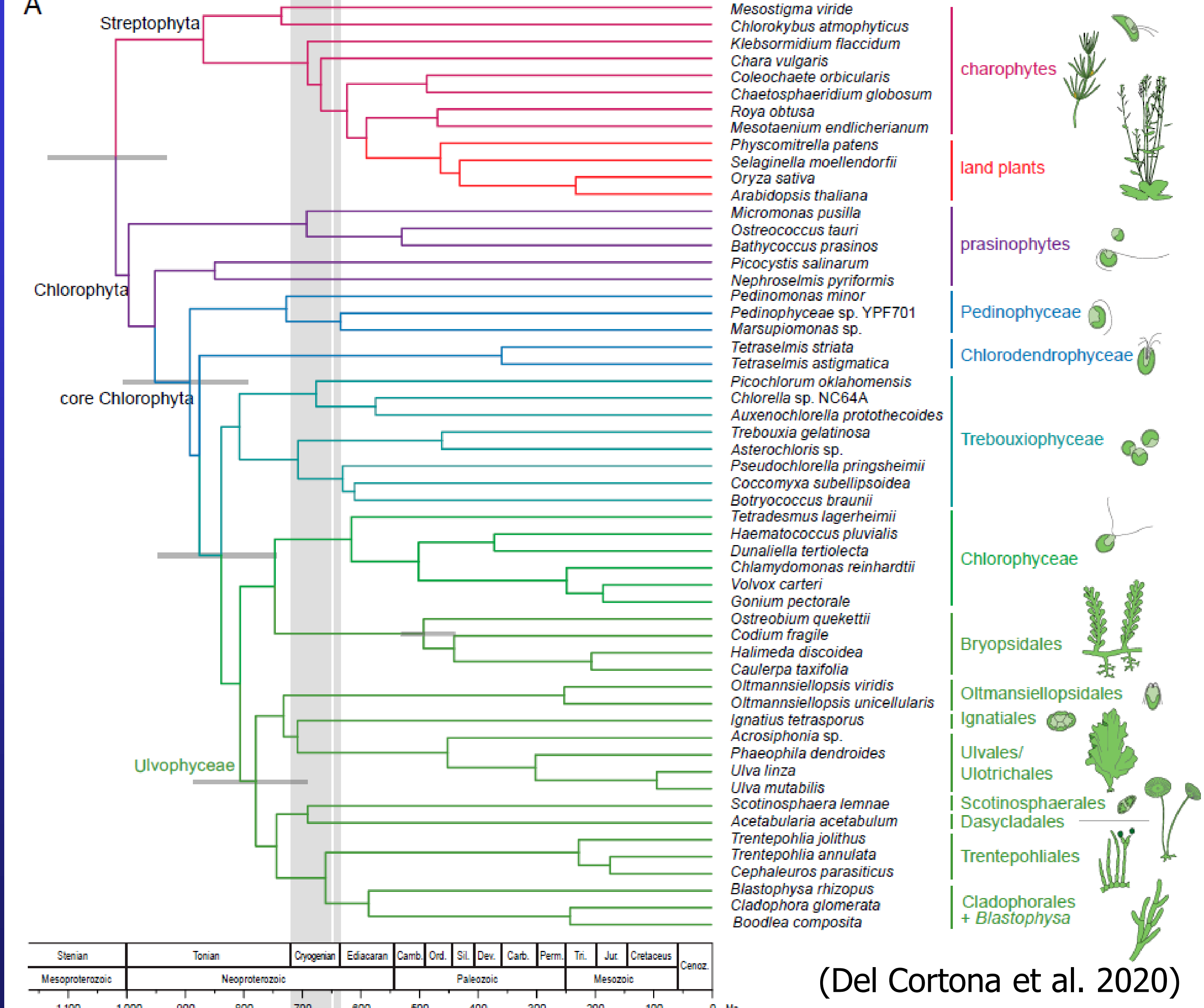
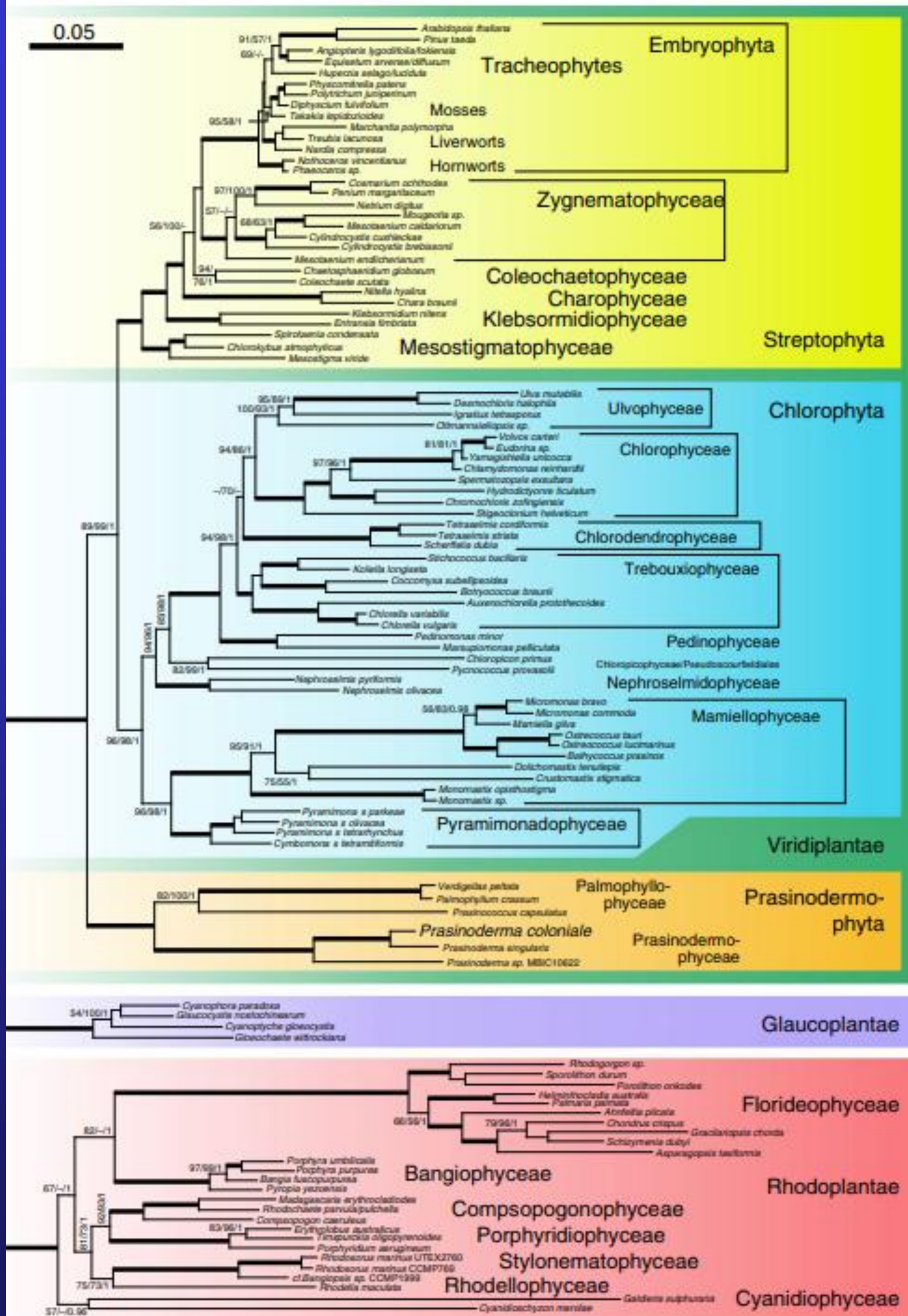
Chlorophyta

Prasinophyta

Ulvophyceae

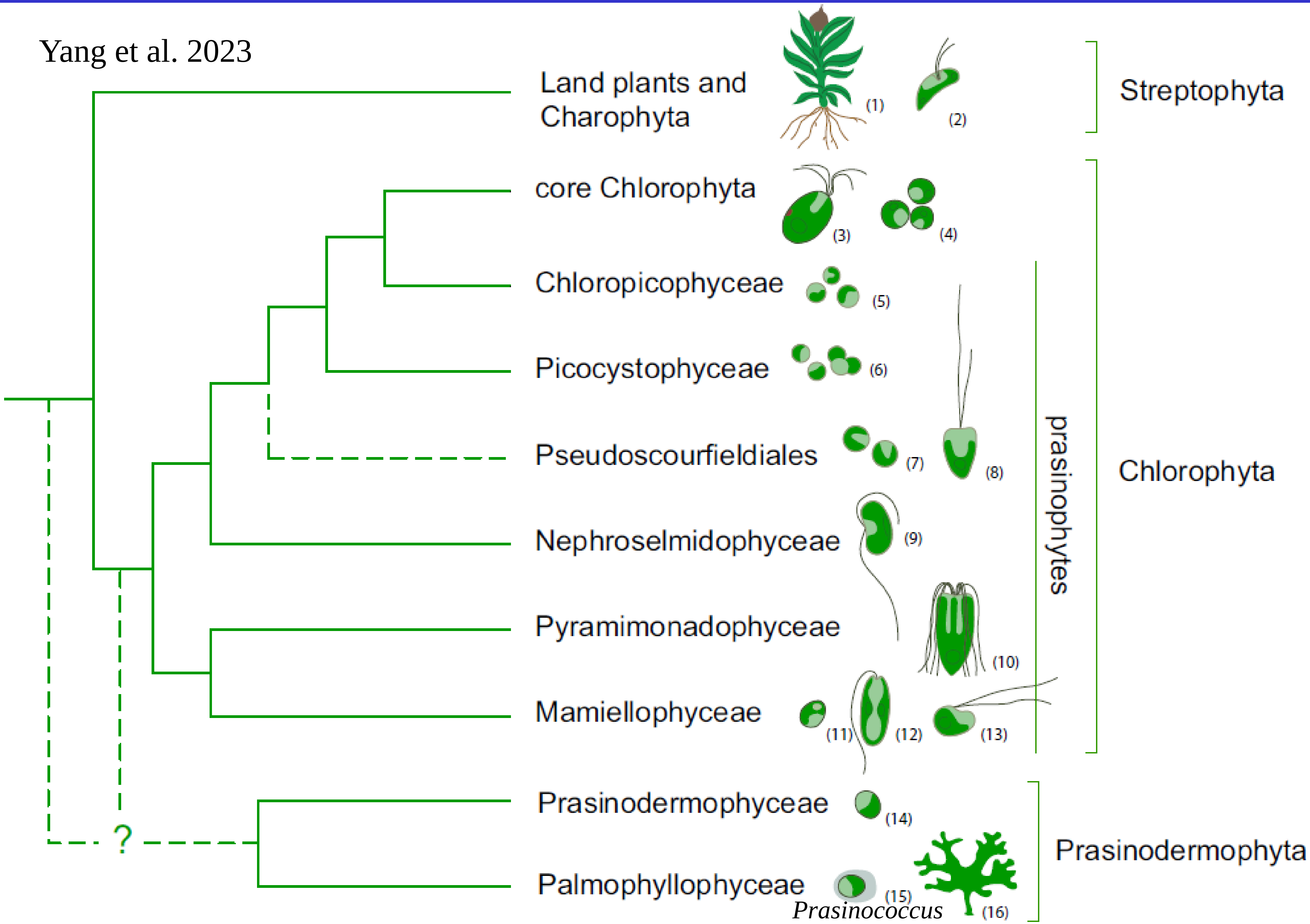


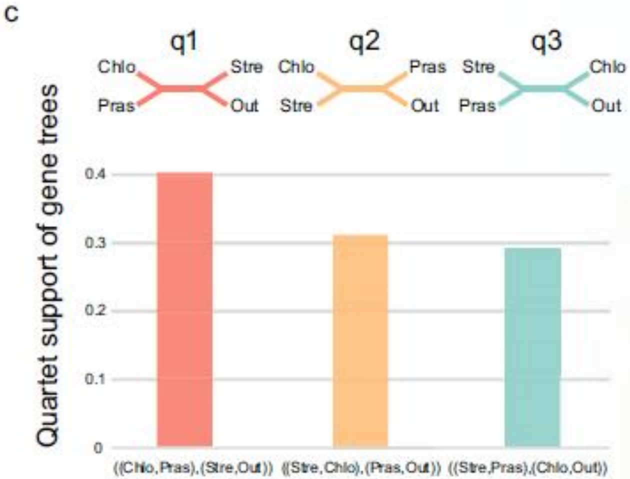
Time-calibrated phylogeny of the green algae. (A) The topology of the tree is based on the ML analysis inferred from a concatenated amino acid alignment of 539 nuclear genes

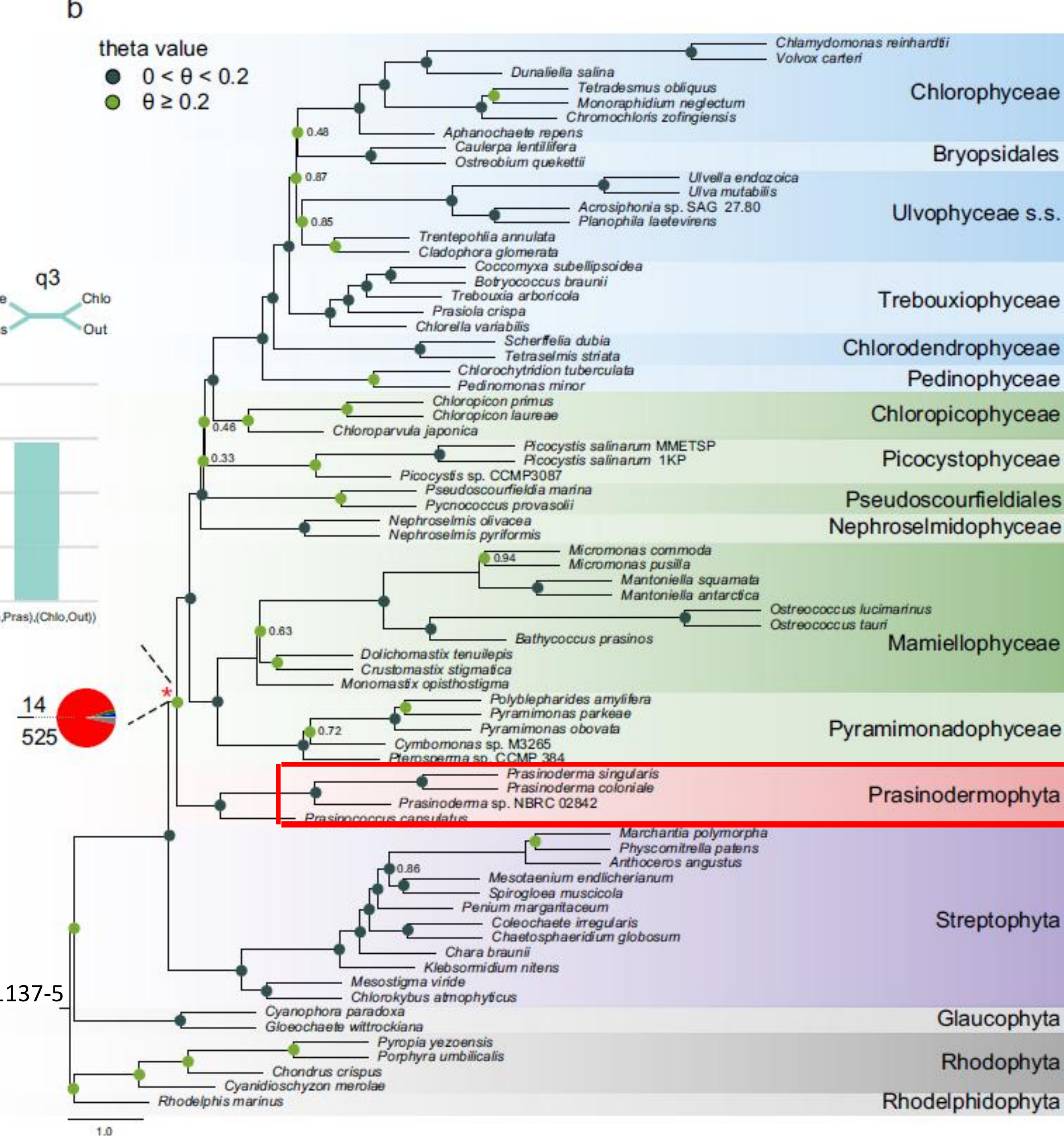


Li et al. 2020
https://doi.org/10.1038/s41559-020-1221-7

Yang et al. 2023

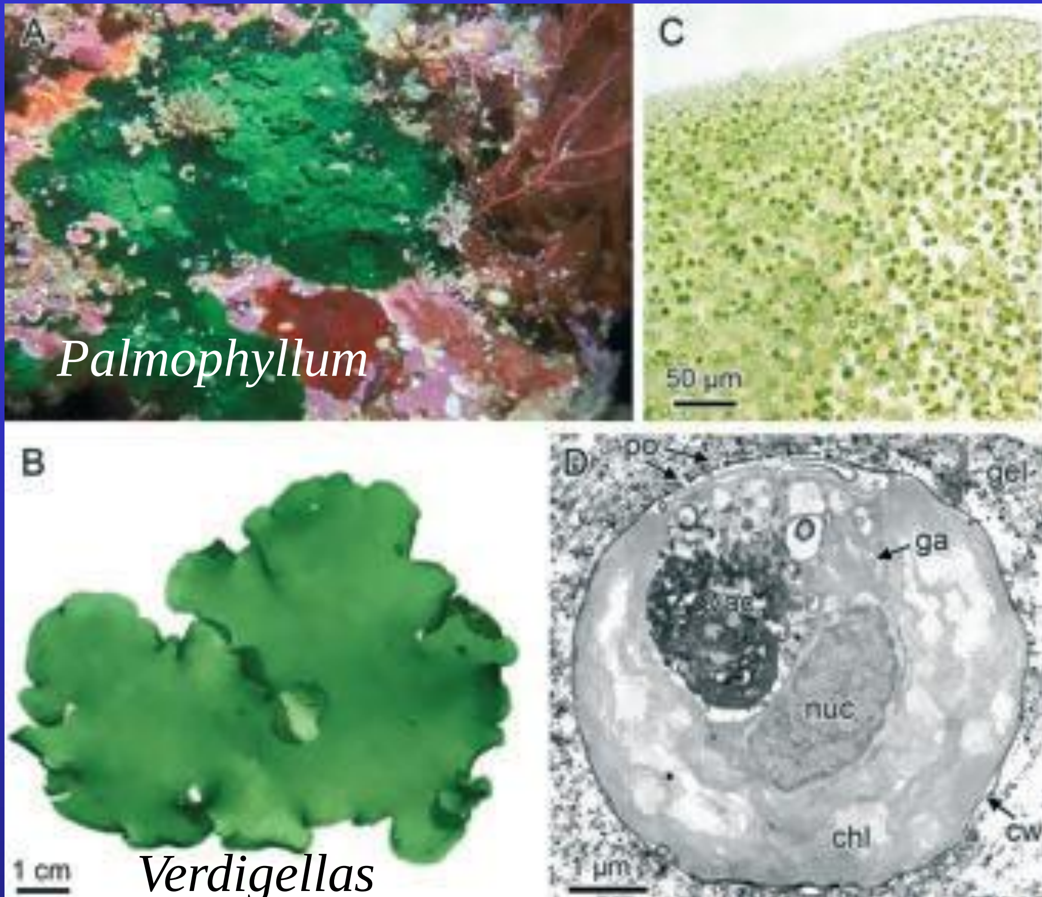






Yang et al. 2023

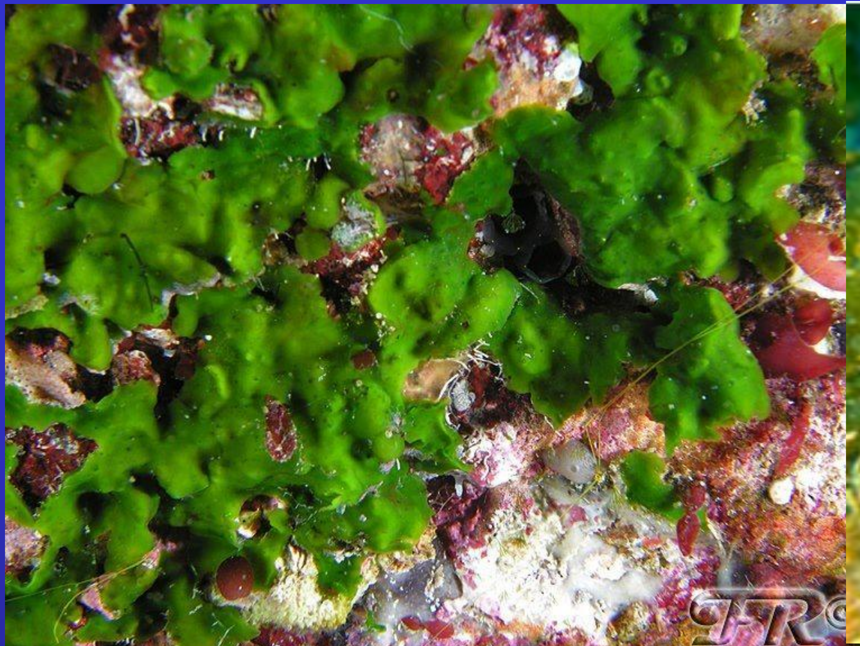
https://doi.org/10.1038/s41467-023-41137-5



Palmophyllales

deep-marine group of algae

phylogenetic relicts



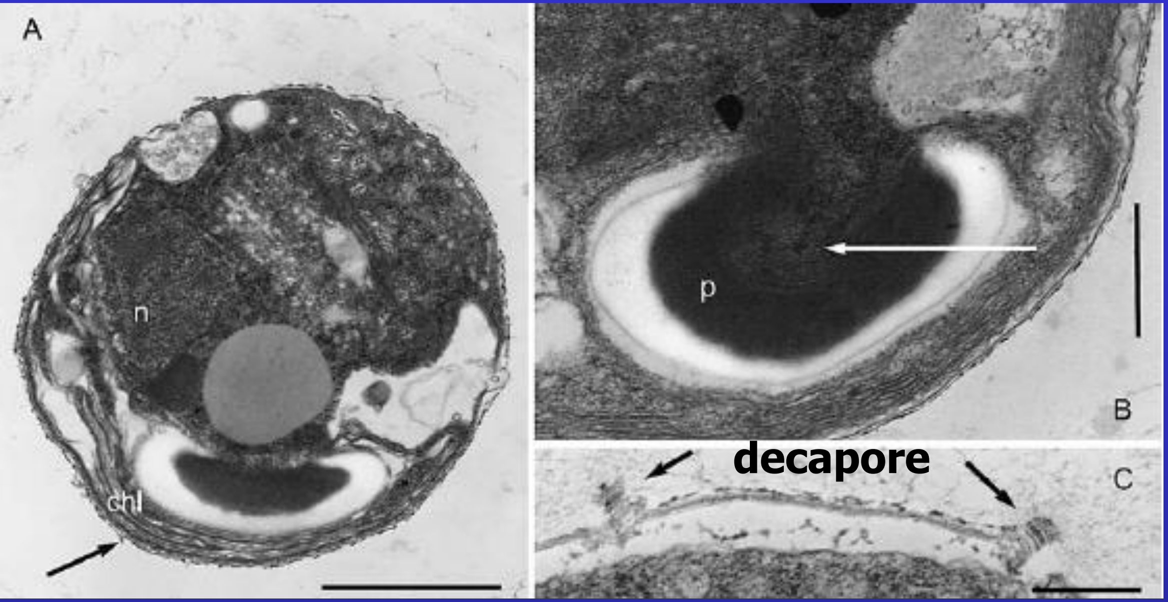
Palmophyllum crassum –
Mediterranien Sea

Palmoclathrus stipitatus.
This rare and remarkable alga has a stem that shows annular rings, out of which grows a delicate, cupshaped, perforated membranous blade. Individual plants up to 8 years of age have been recorded
South Australia

higher ch b/ch a ratio
no siphonaxanthin and siphonein

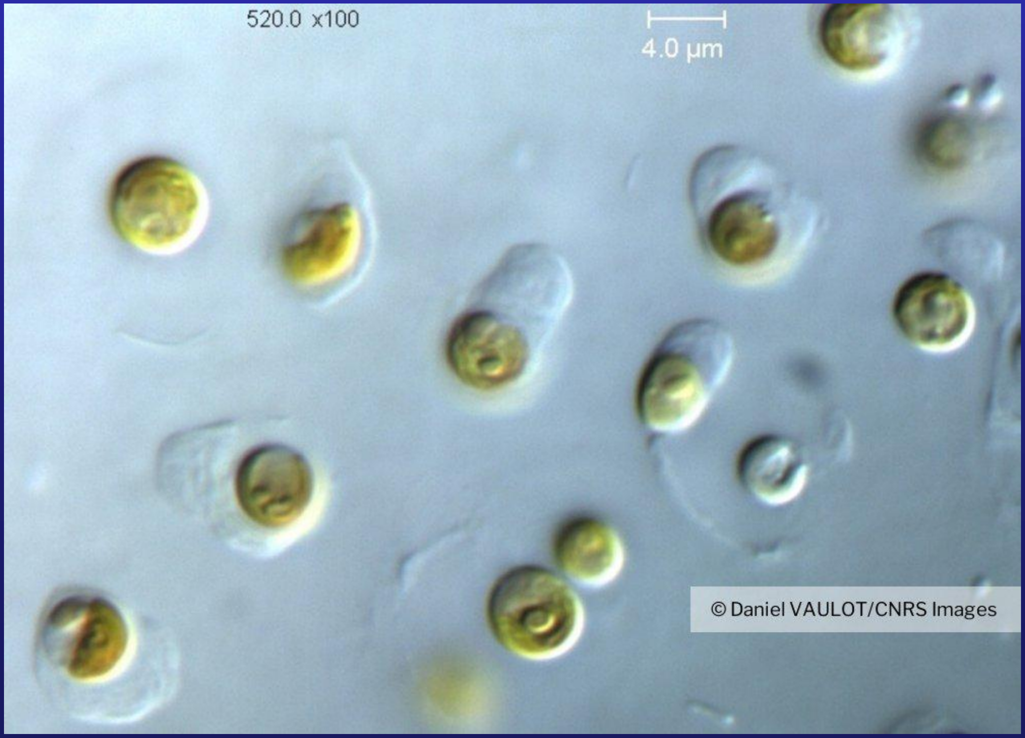
Palmophylophyceae

Prasinococcus cf *capsulatus*



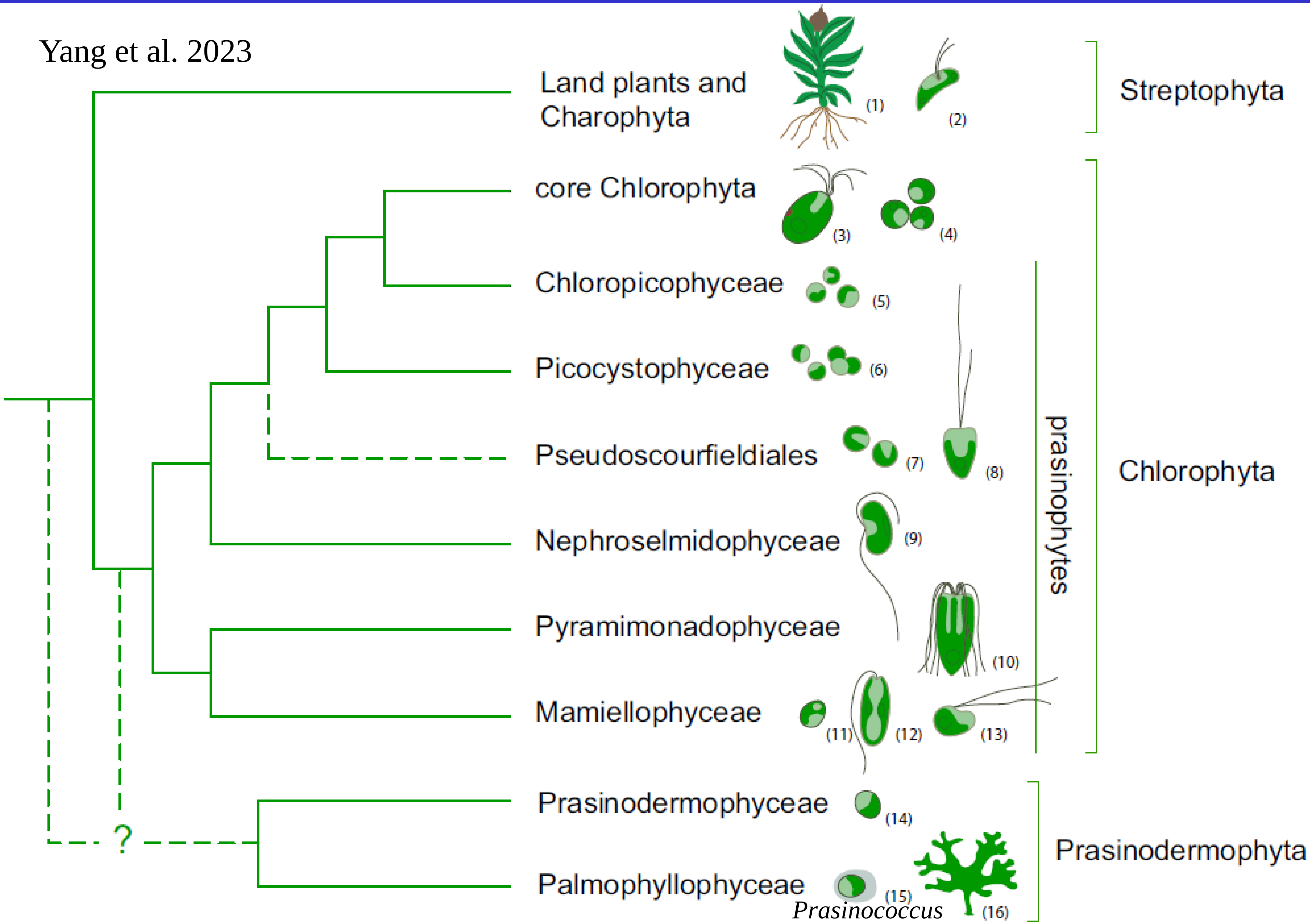
Coccal (pico)planktonic prasinofyte - 3.5 to 5.2 µm

Asexual reproduction is achieved by unequal binary fission in which one of the daughter cells retains the parent wall, while the other is released with a newly produced cell wall



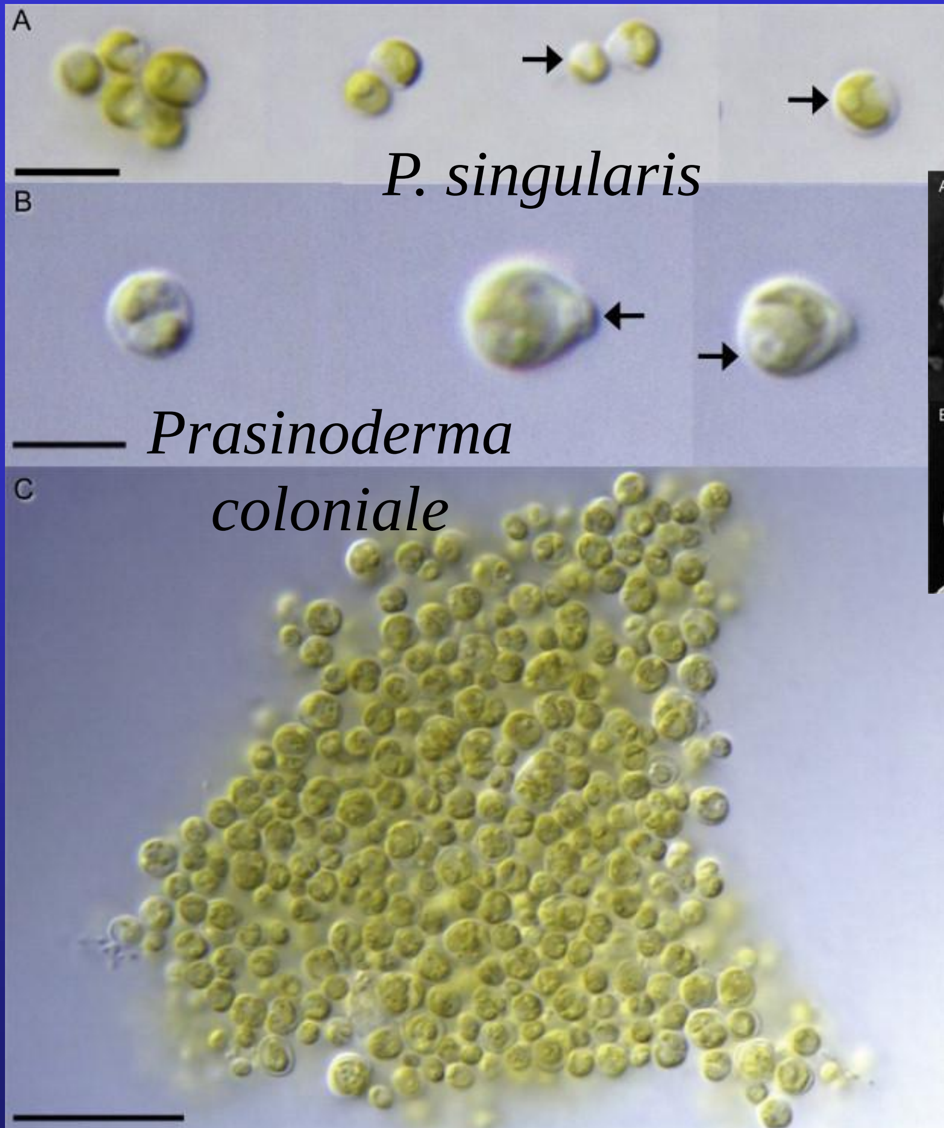
Guillou et al. 2004

Yang et al. 2023



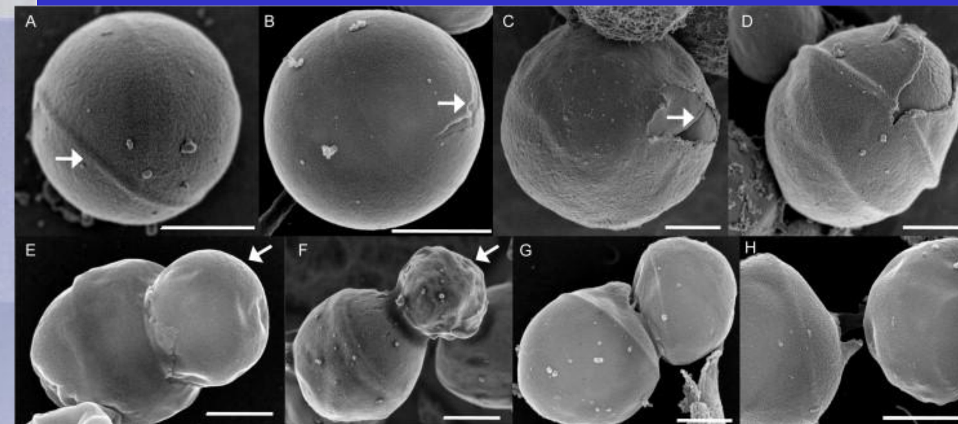
Prasinodermohylophyceae

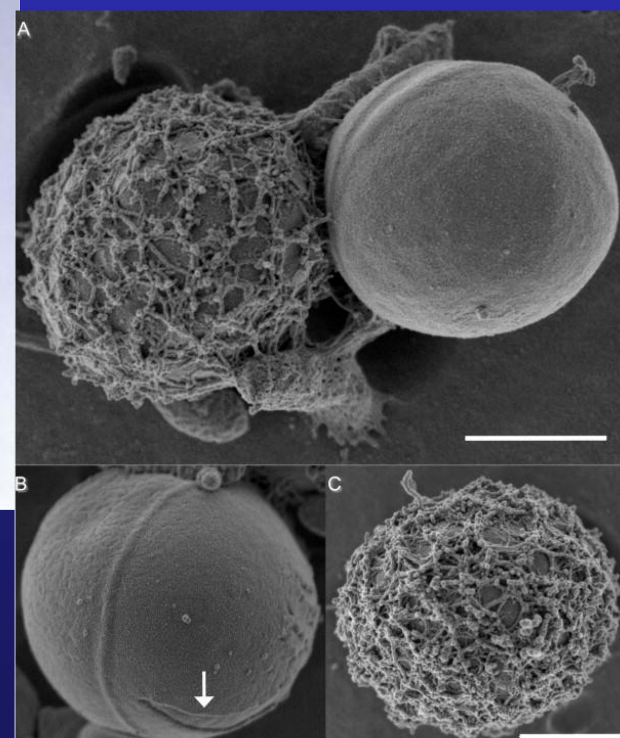
Prasinoderma



Surface water of Pacific Ocean.
Bioscope expedition 2004

(Jouenne et al. 2011)





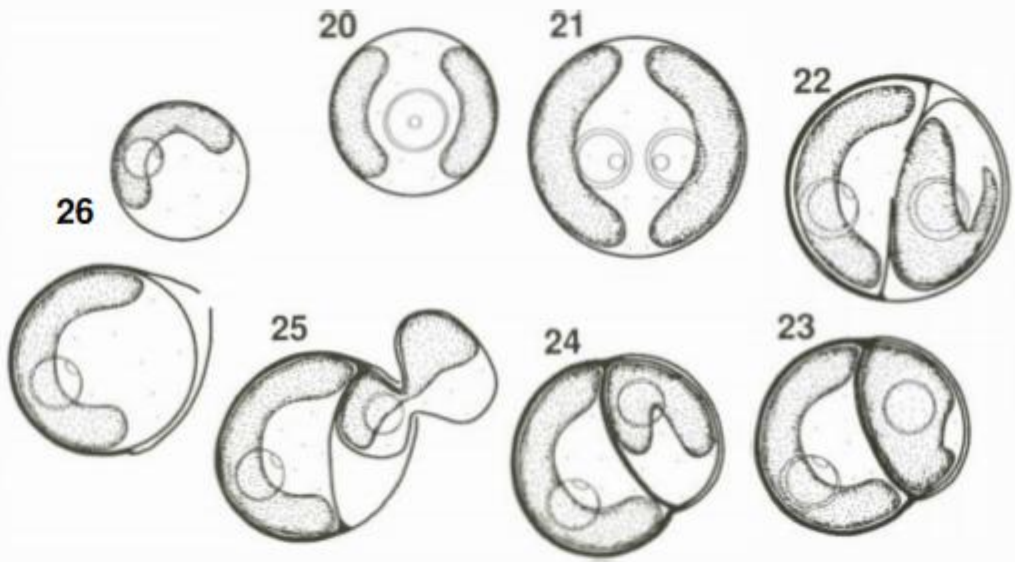
Ch a,b prasinoxan-thin, micromonol uriolide

Asexual reproduction by unequal binary fission and “budding-like” process

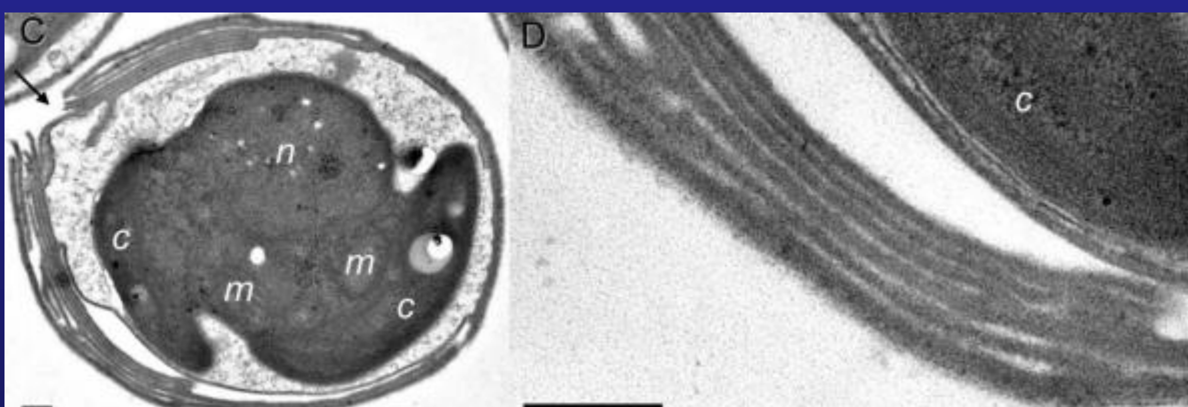
Prasinoderma coloniale

(HASEGAWA et al. 1996)

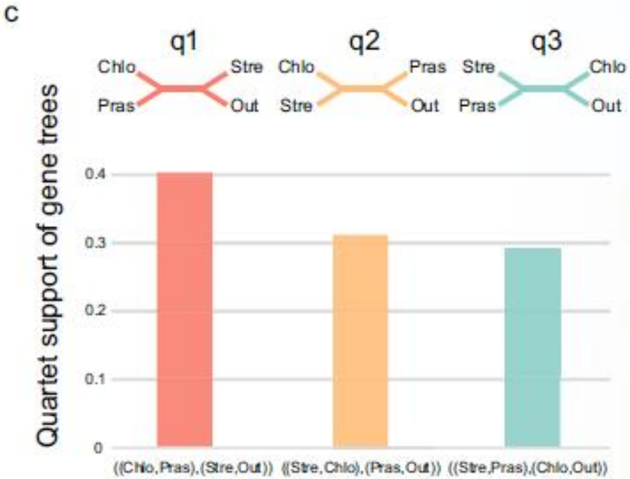
Hasegawa et al.: *Prasinoderma coloniale* gen. et sp. nov.

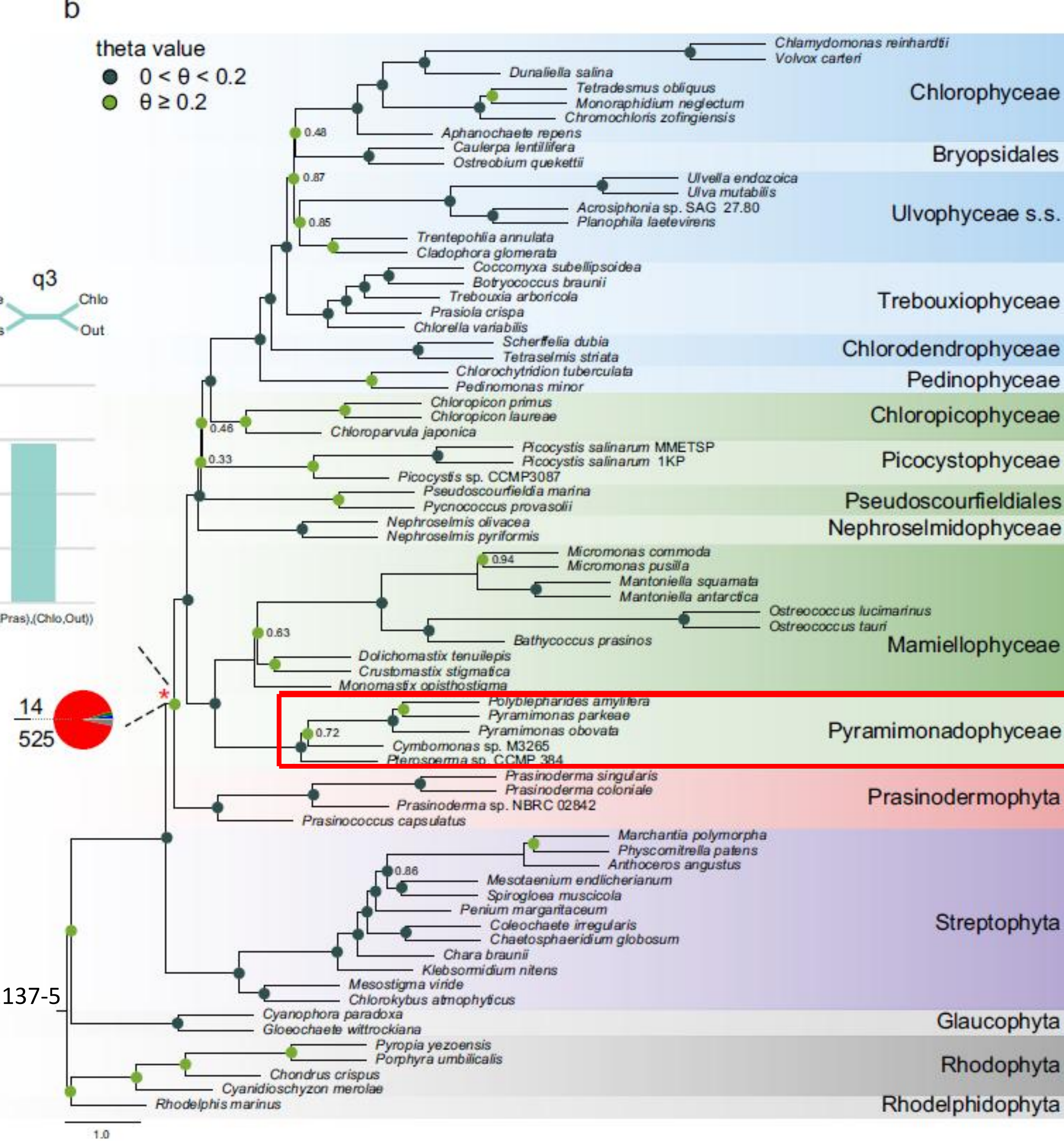


Figs 20–26. *Prasinoderma coloniale.* Schematic illustrations showing the process of asexual reproduction.



(Jouenne et al. 2011)



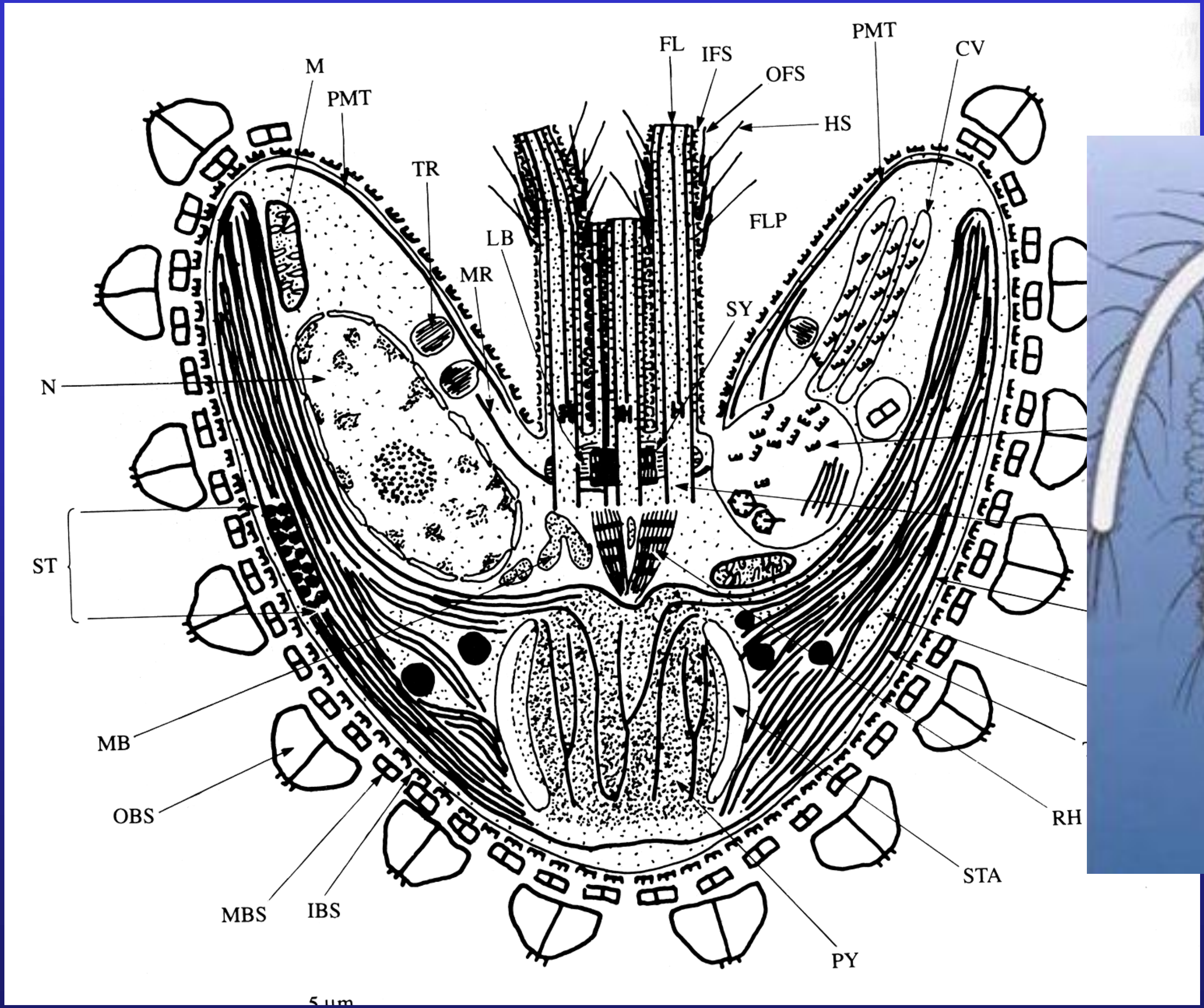


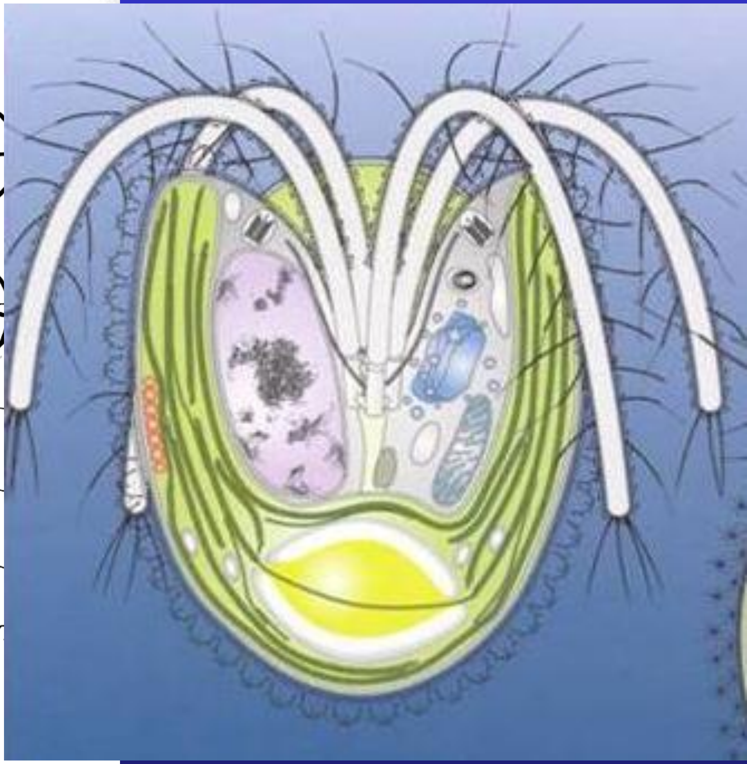
Yang et al. 2023

https://doi.org/10.1038/s41467-023-41137-5

Pyramimonadales

no prasinoxanthin
70 species





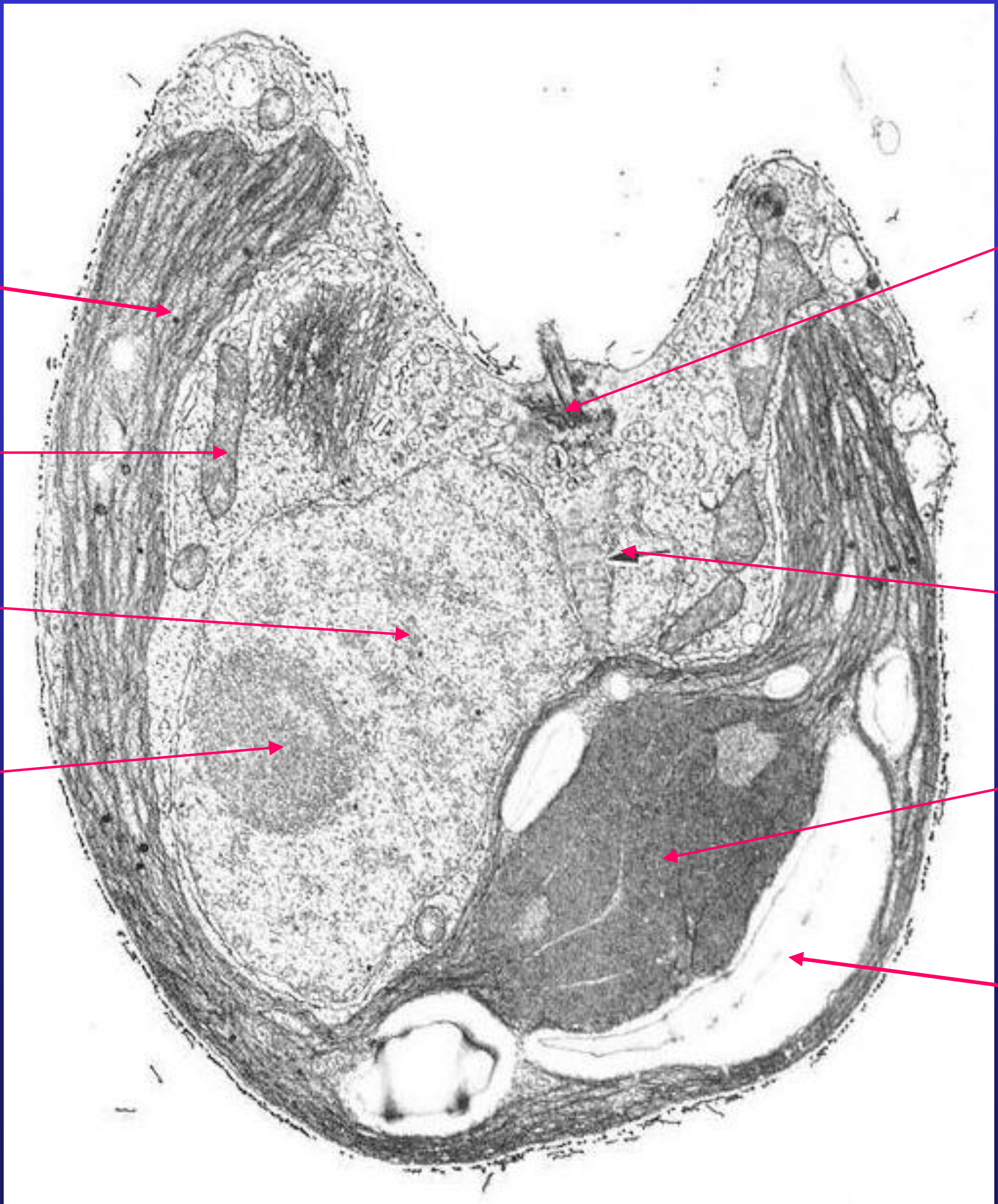
rhizoplast attached to the chloroplast surface (contraction ATP, Ca^{2+})

trichocysts- extracellular digestion

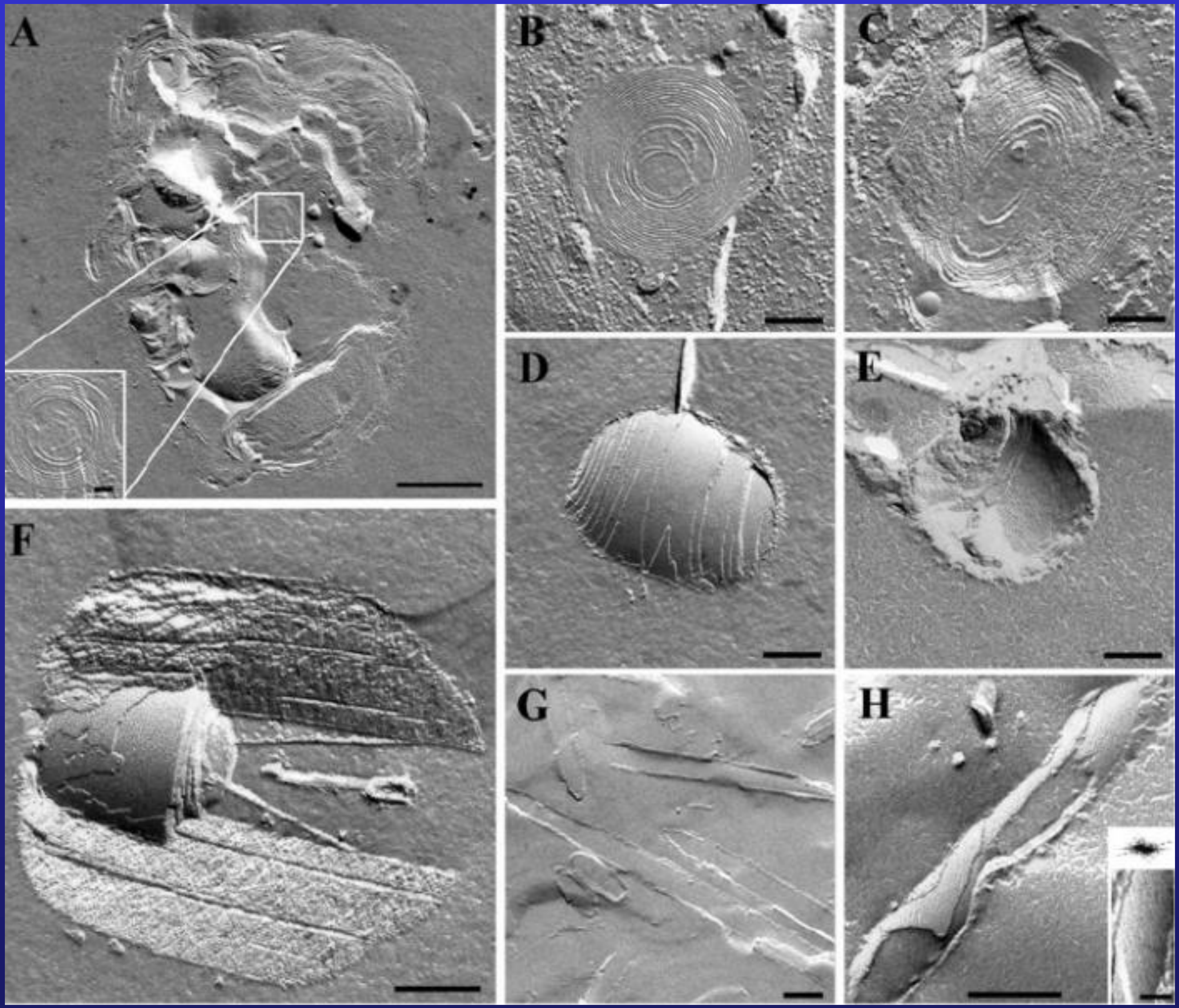
ultrastructure of *Pyramimonas*

Pyramimonadales

Cymbomonas



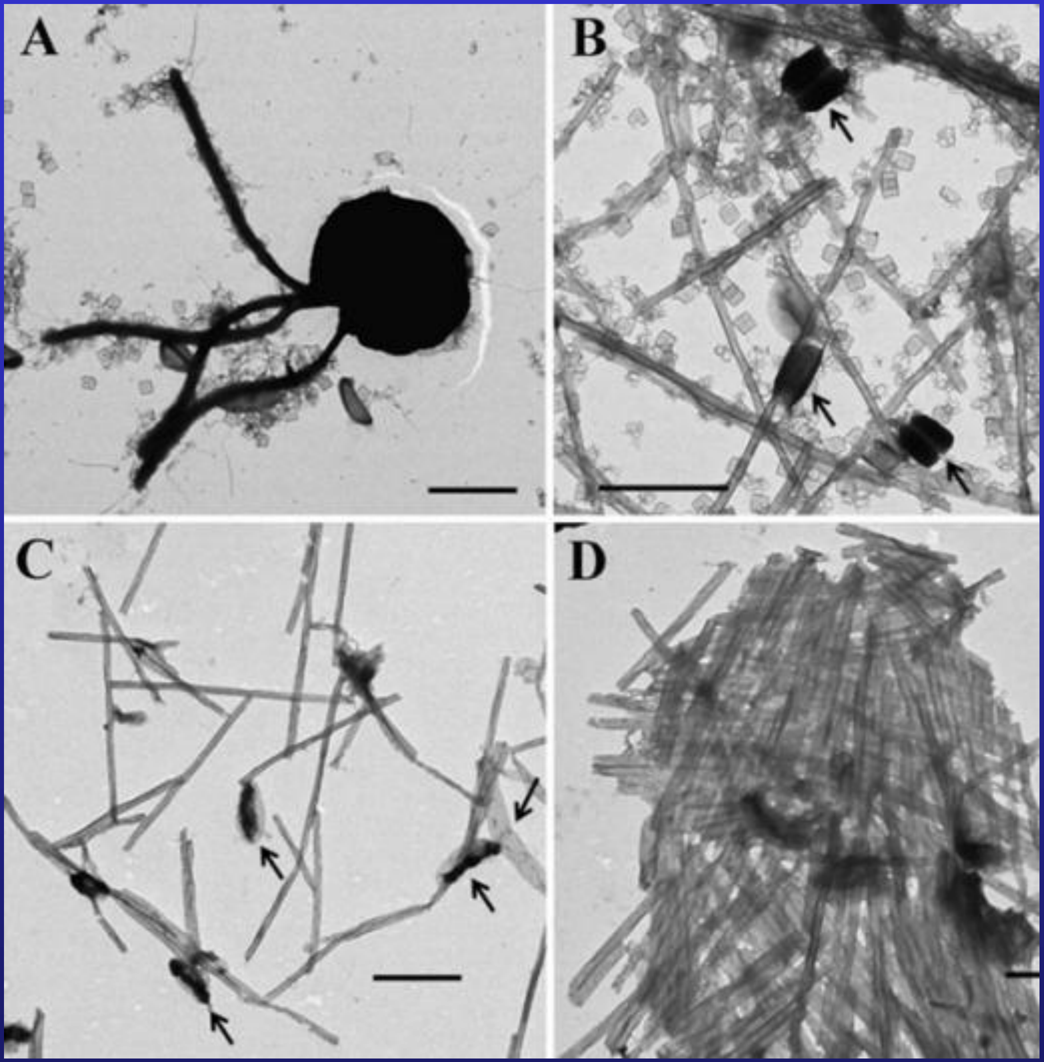
Ejectisomes



Discharged ejectisomes measured up to 26 µm still furled measured up to 900 nm in width and 1 µm in length

Rhiel et al.
Protoplasma 2013

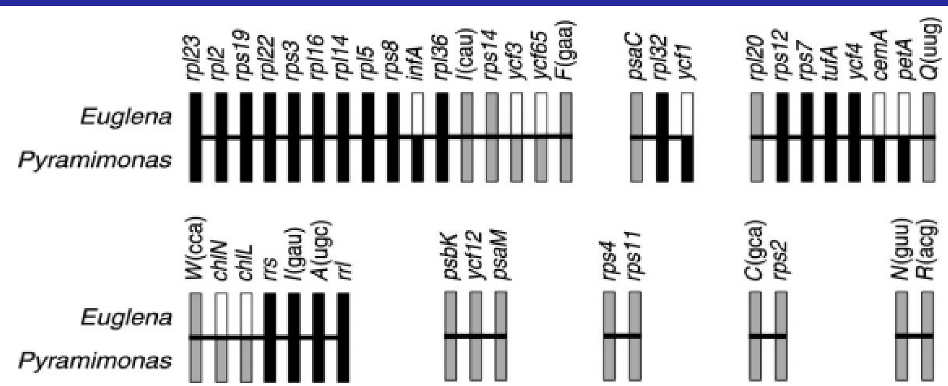
Micrographs of freeze-fractured ejectisomes of *P. grossii*. In freeze-fractured *Pyramimonas* cells



Micrographs of a cell of P. grossii (a) and of crude (b) and enriched (c, d) ejectisome fractions after negative staining.

Pyramimonas parkeae -
the closest relative to the euglena chloroplast

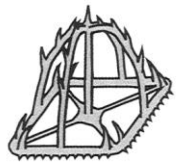
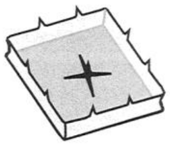
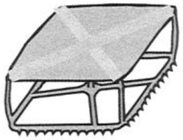
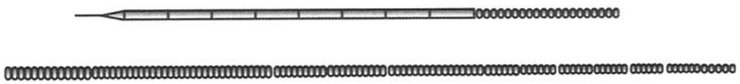
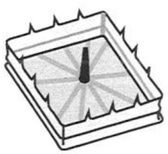
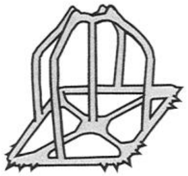
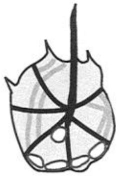
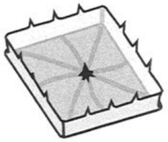
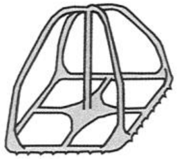
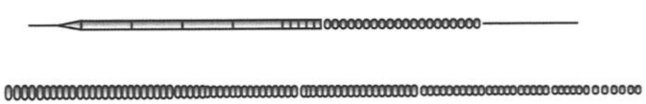
Plastid genoms share unique gene clusters



Obr. 1. Genové klastry unikátně sdílené cpDNA organismů *Euglena* a *Pyramimonas* podle Turmelové et al. (2009). Černě vybarvená políčka naznačují ancestrální uspořádání těchto klastrů (vyskytující se i u jiných zelených řas), šedá políčka odkazují na derivované oblasti (specifické pro *Euglena* a *Pyramimonas*) a prázdná políčka označují chybějící geny.

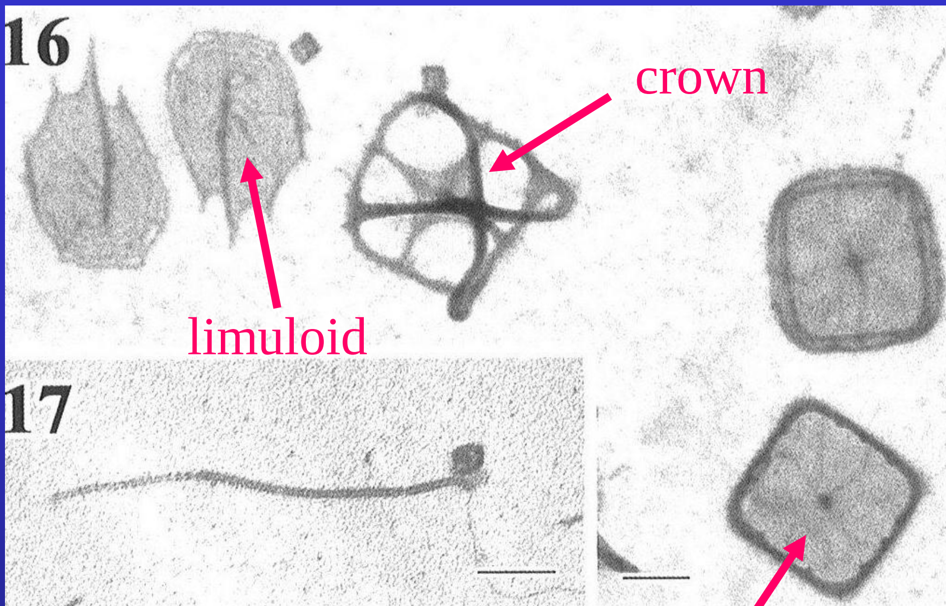
Organic scales

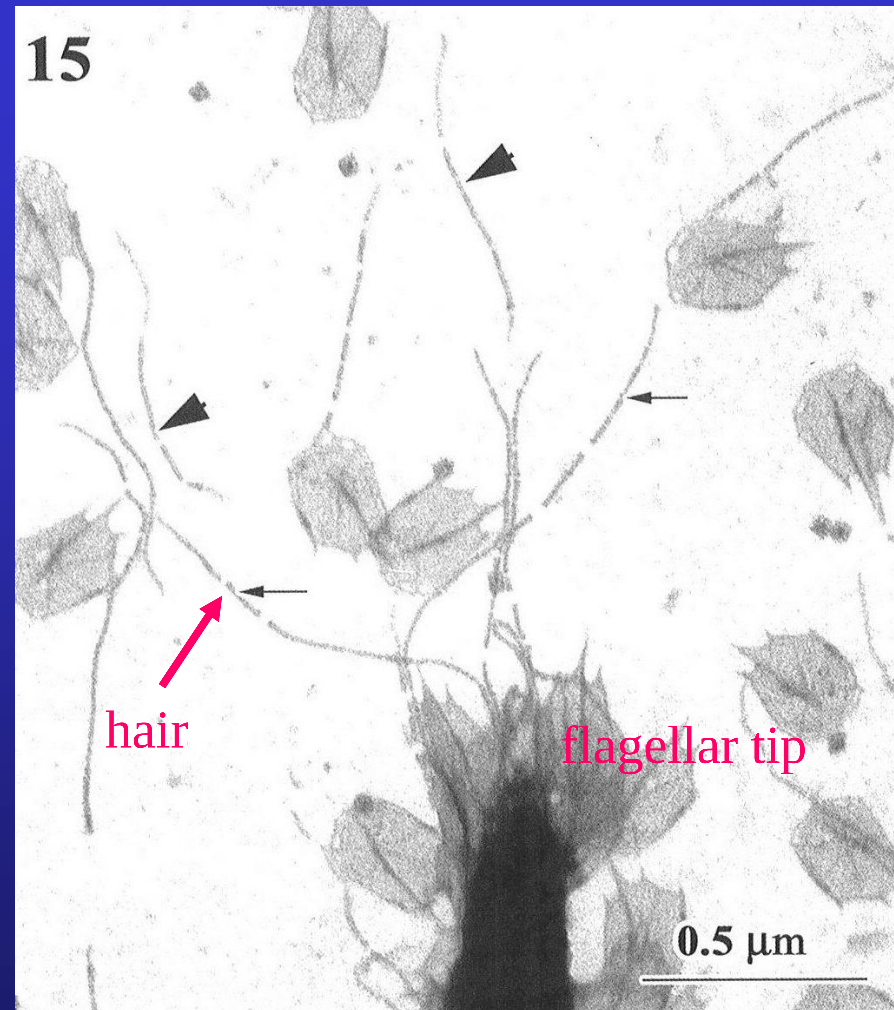
Table 3. Comparison of the body (box and crown) scales and the flagellar (limuloid and hair) scales among species of *Pyramimonas* subgenus *Punctatae*.

species	body scales		flagellar scales	
	box scale	crown scale	limuloid scale	hair scale
P. formosa[1]				
P. mucifera[2]				
P. olivacea[3]				
P. robusta[4]				
P. aurea[5]				

[1]Sym & Pienaar 1999; [2]Sym & Pienaar 1991, Pienaar & Sym 1997; [3]McFadden *et al.* 1987, Pienaar & Sym 1997; [4]Pienaar & Sym 1997; [5]this study

Organic scales

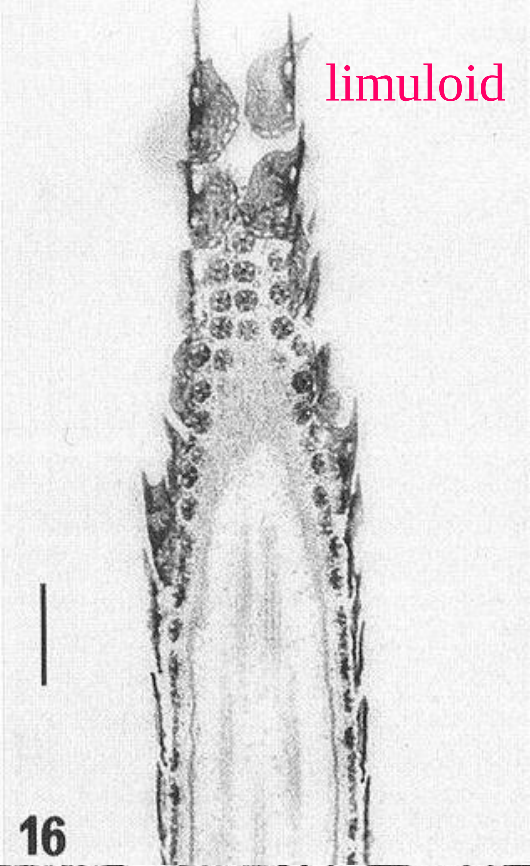


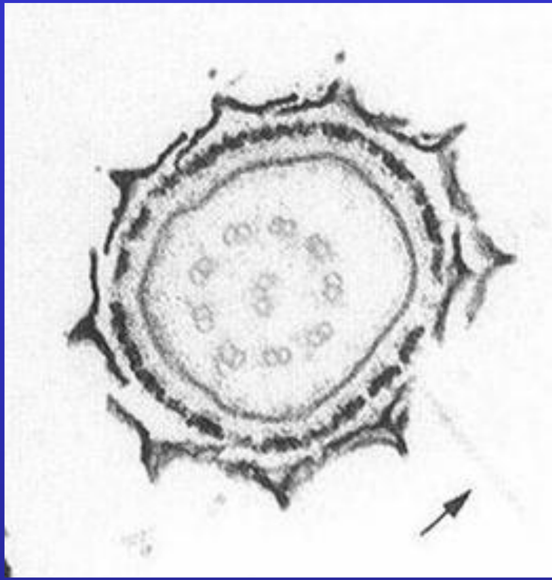


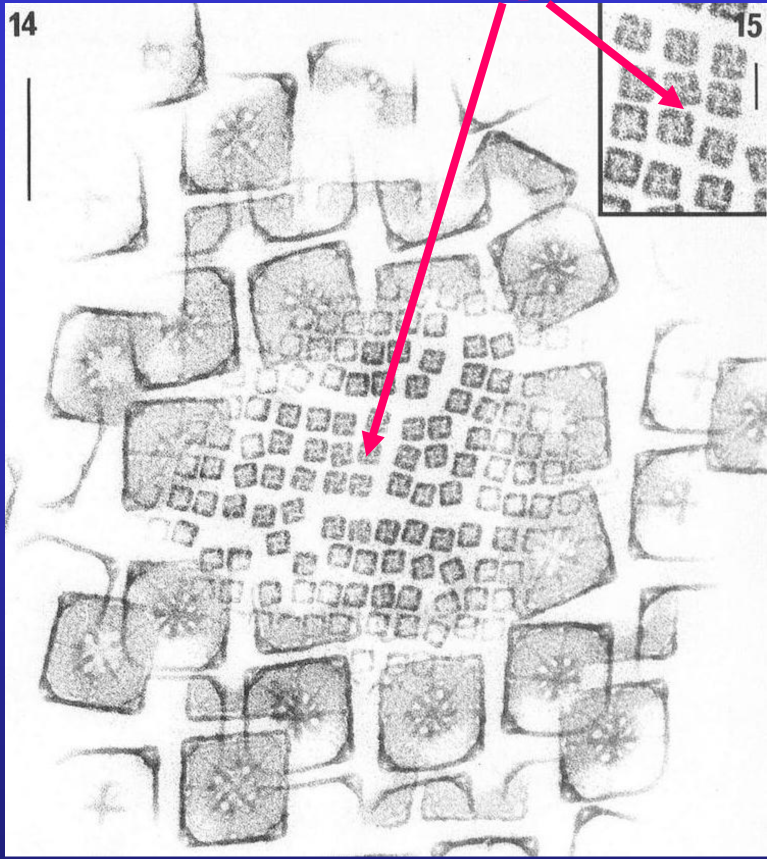
Pyramimonas aurea

carbohydrate similar to pectin

Organic scales





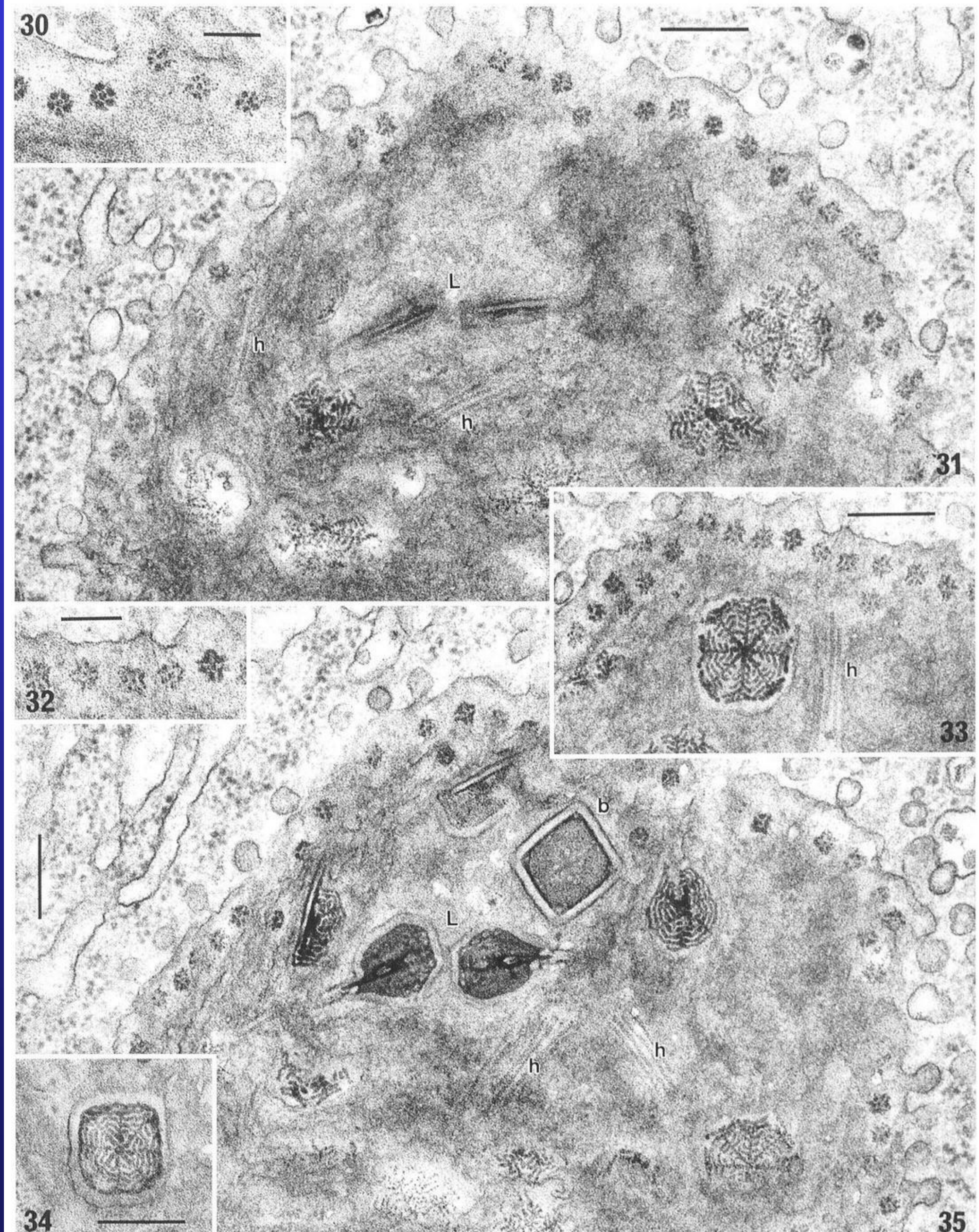


Cymbomonas tetramitiformis

Scales produced by GA – all types of body and flagellar scales can be produced in a single GA cisterna, secreted to the surface in the area of flagellar insertion (flagellar pit).

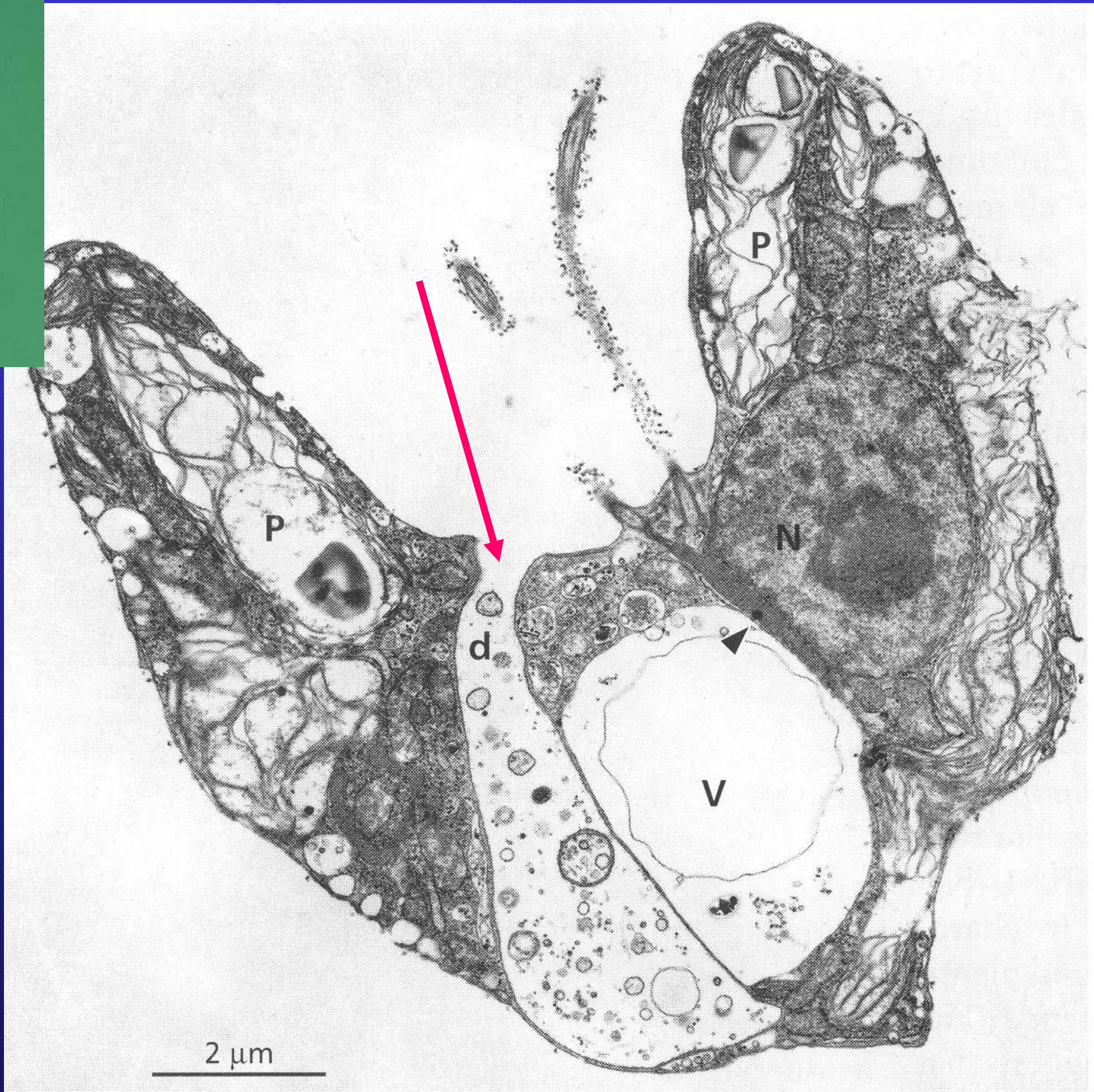
x chrysophyte silica scales

Cymbomonas



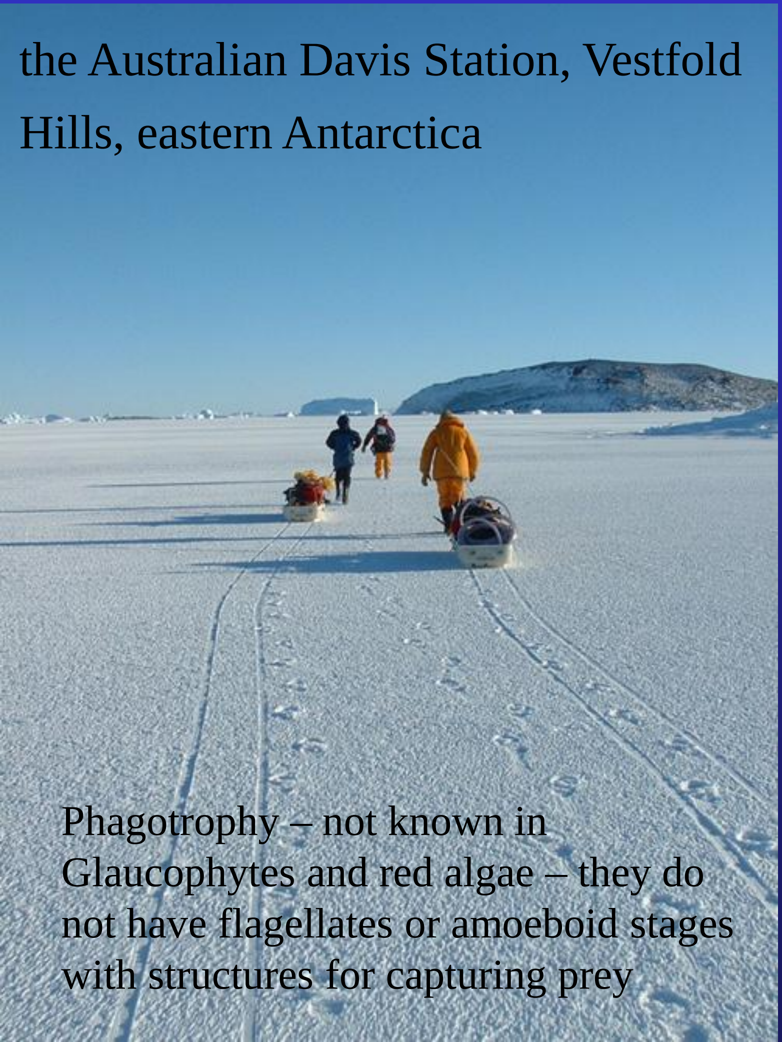
Organic scales

Halosphaera – specialized channel through which scales are released, vestigial cytopharynx of ancestral phagotrophic cells



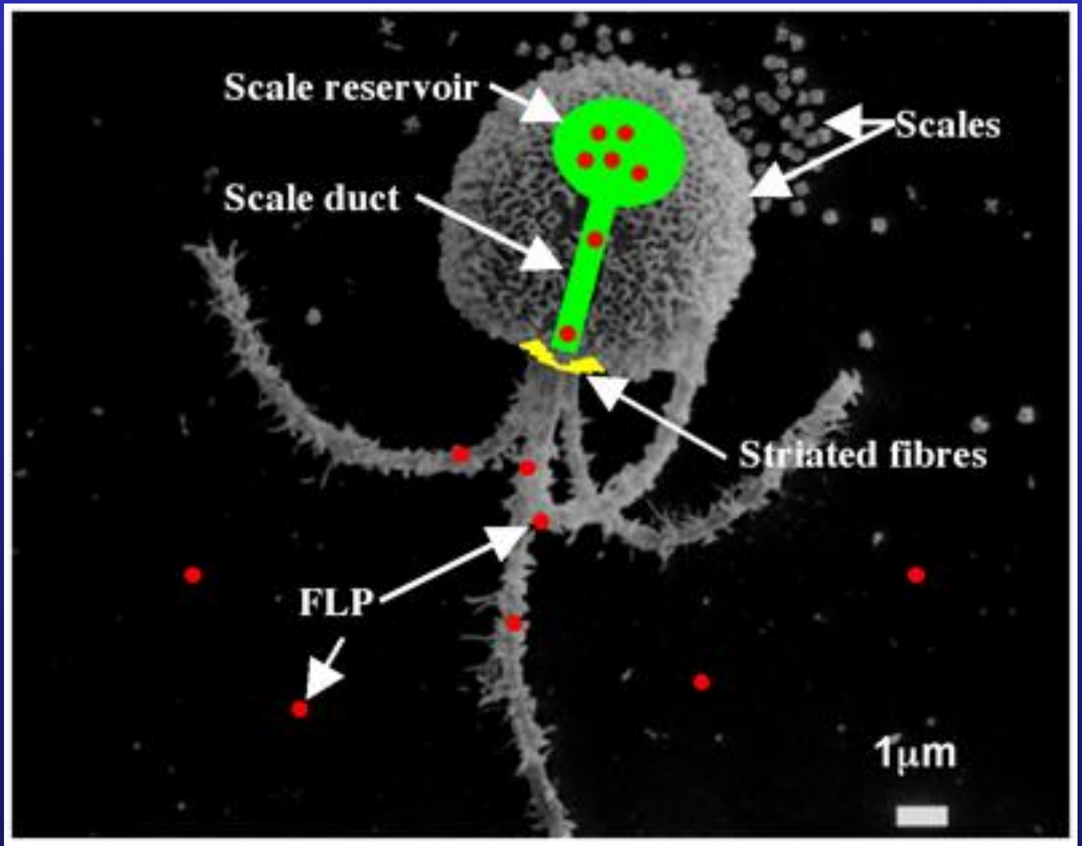
Mixotrophy 'activated' only under extreme conditions (total winter darkness and again when ice thickness was maximal and PAR levels in the water column low) – trophic plasticity

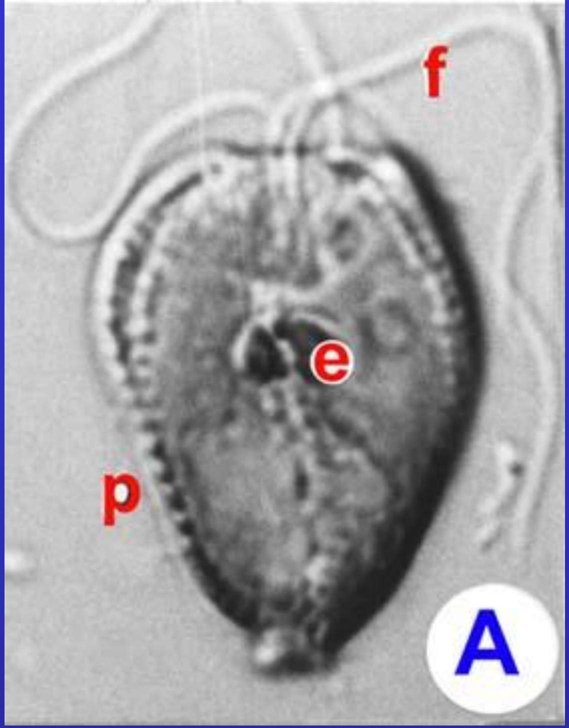
the Australian Davis Station, Vestfold Hills, eastern Antarctica



Phagotrophy – not known in Glaucophytes and red algae – they do not have flagellates or amoeboid stages with structures for capturing prey

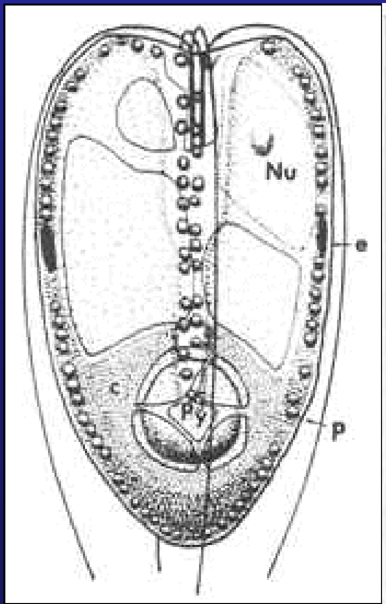
Diagrammatic representation of *Pyramimonas gelidicola* ultrastructure illustrating scale duct and reservoir thought to be involved in prey uptake. FLP, fluorescently labelled prey.

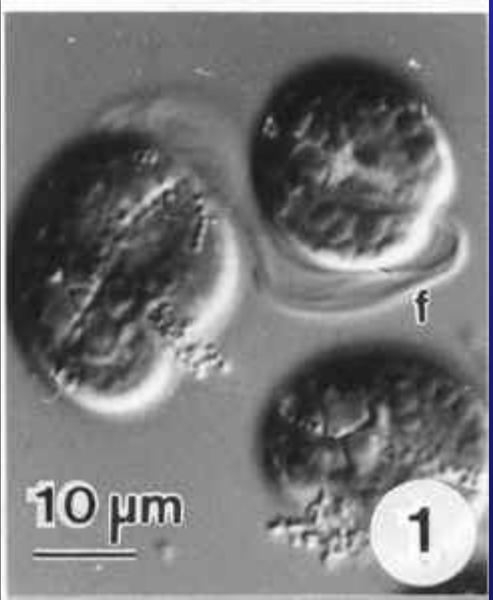




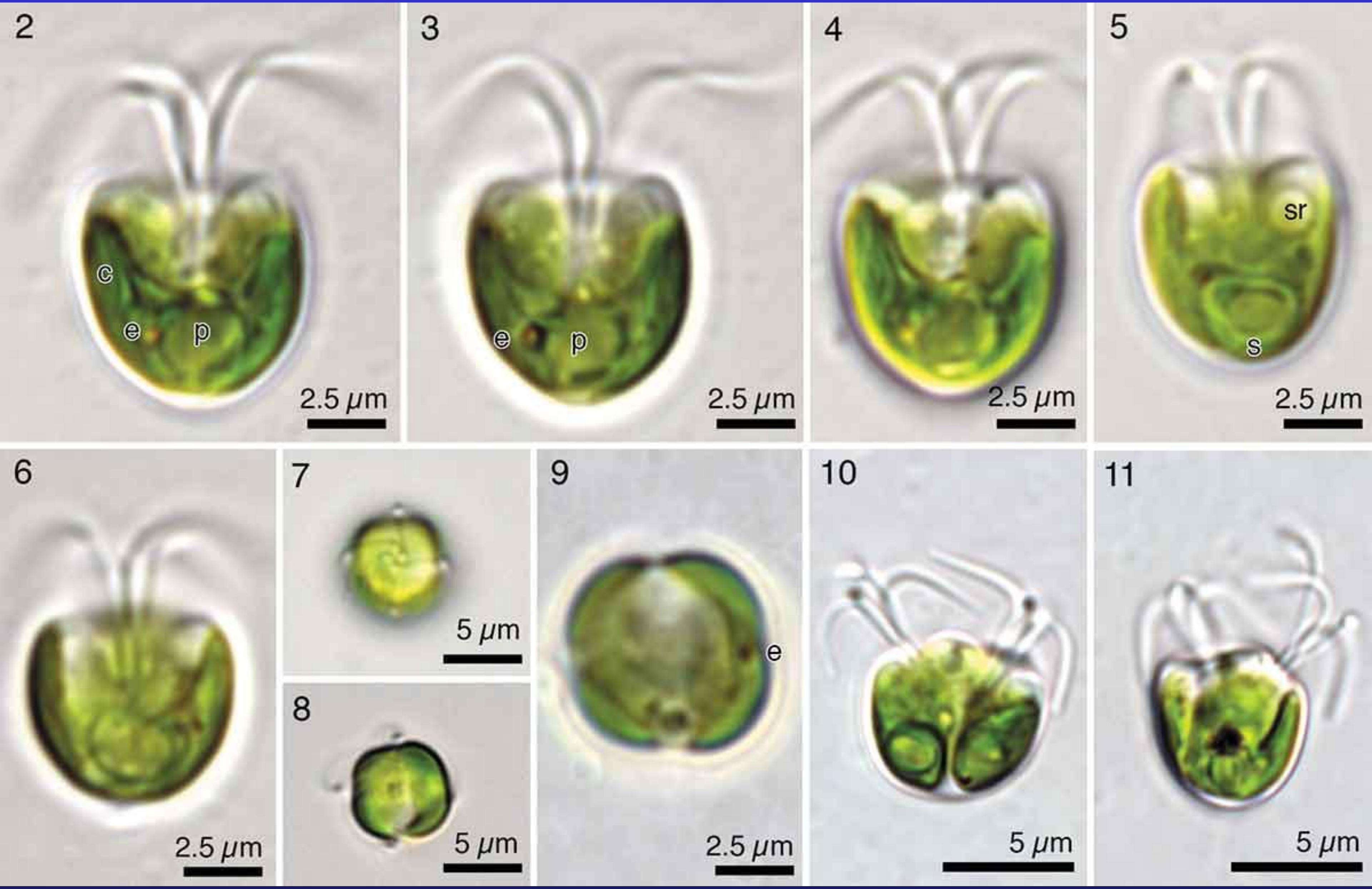
Pyramimonas mucifera

bentic species,
produces slime –
adaptation to bentic
environment





Pyramimonas tatianae longitudinal sections through division stage

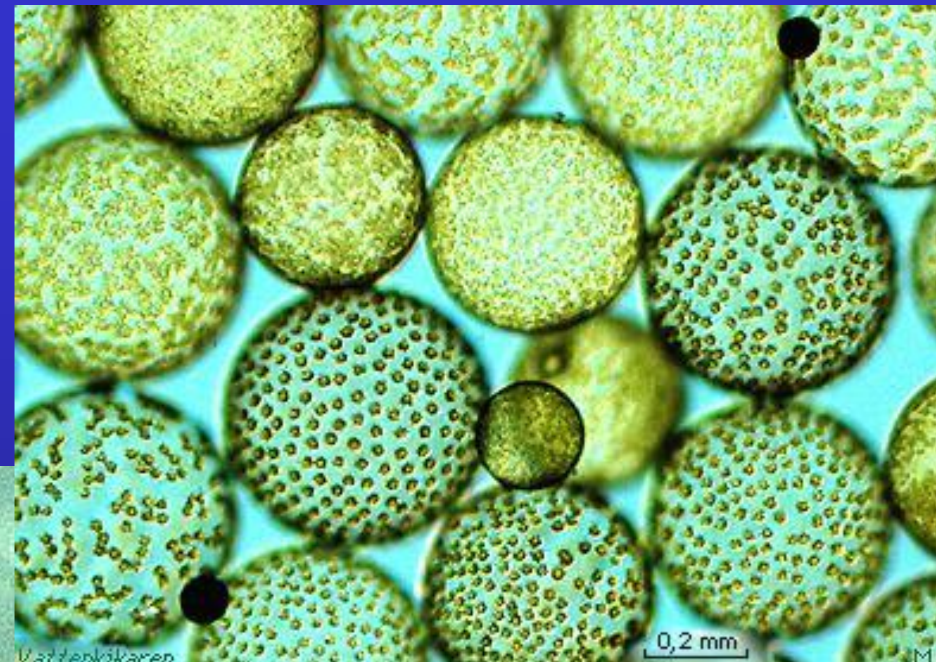


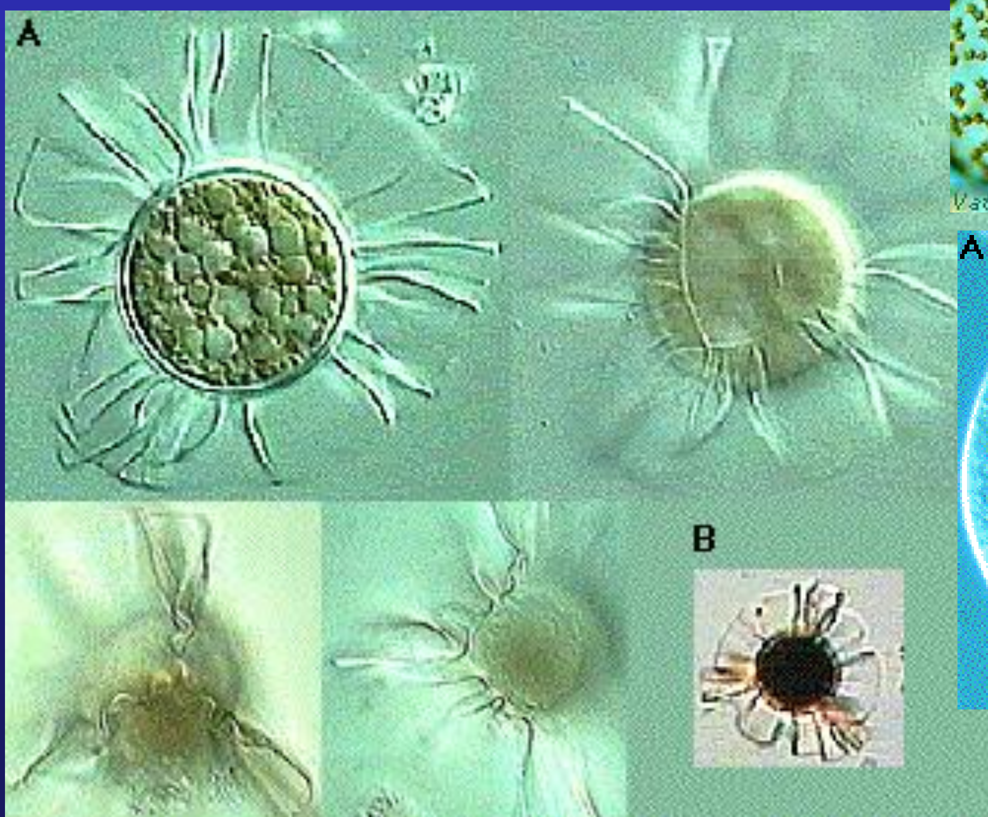
https://doi.org/10.1080/09670262.2019.1638524

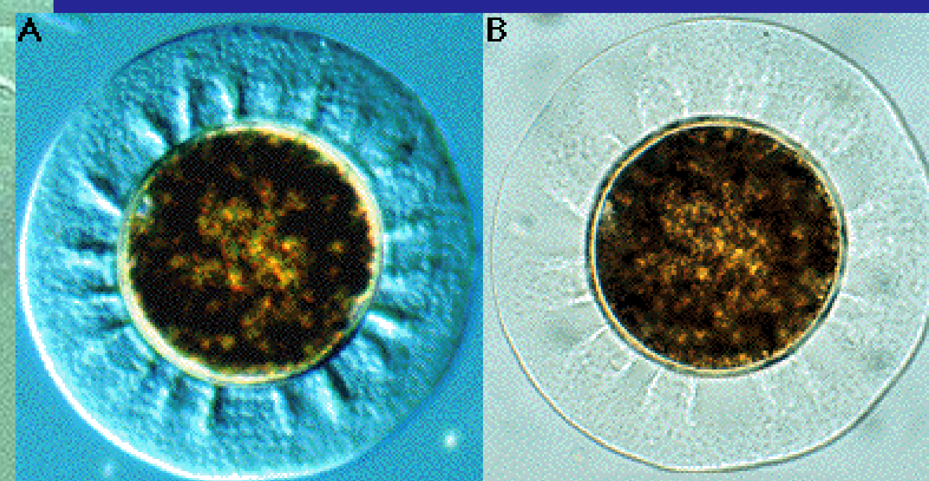
Phycoma

- asexual cysts, resistent outer cell wall
- fossil records from Precambrium (250-540 mya)

Halosphaera





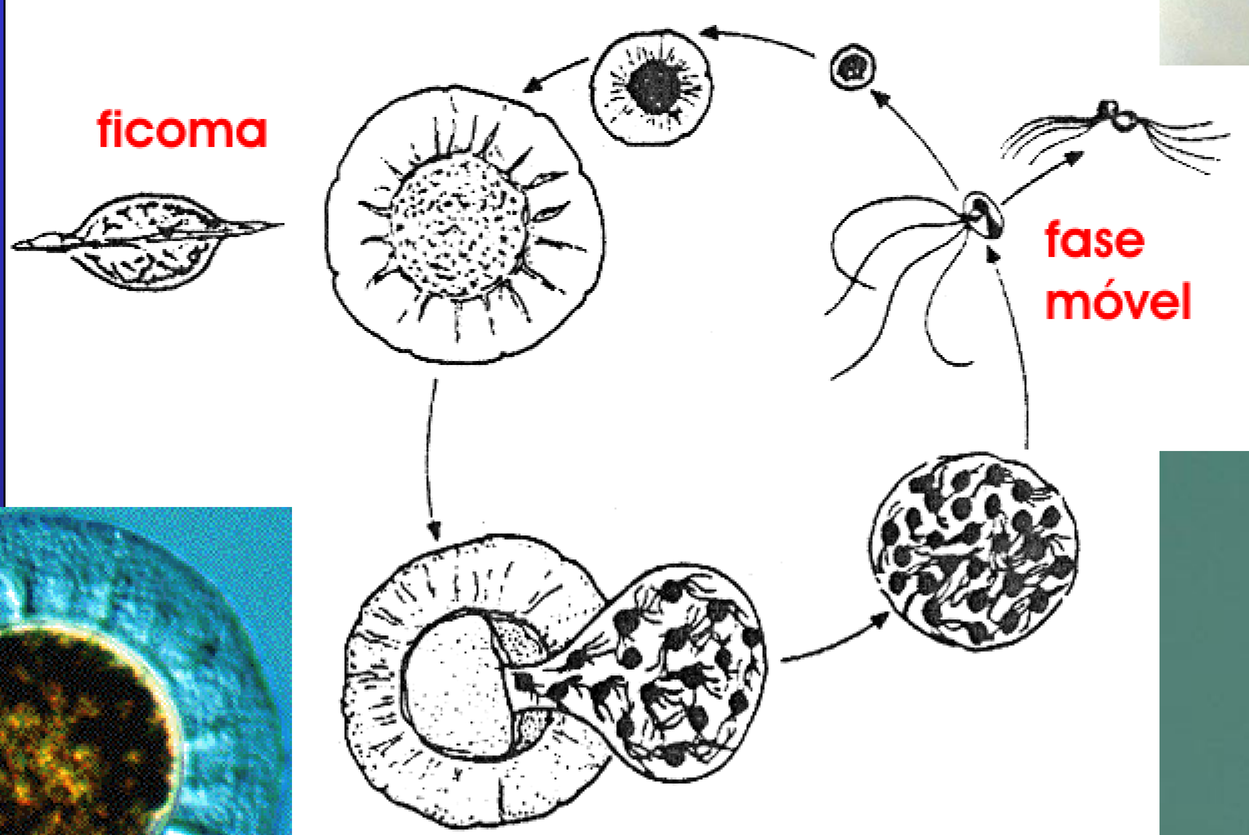


Pterosperma

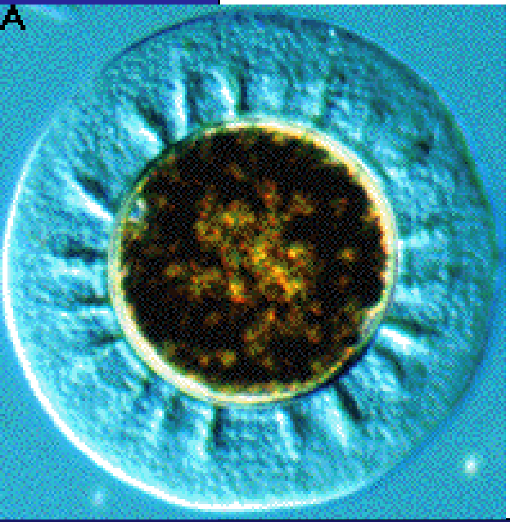
Pyramimonadales

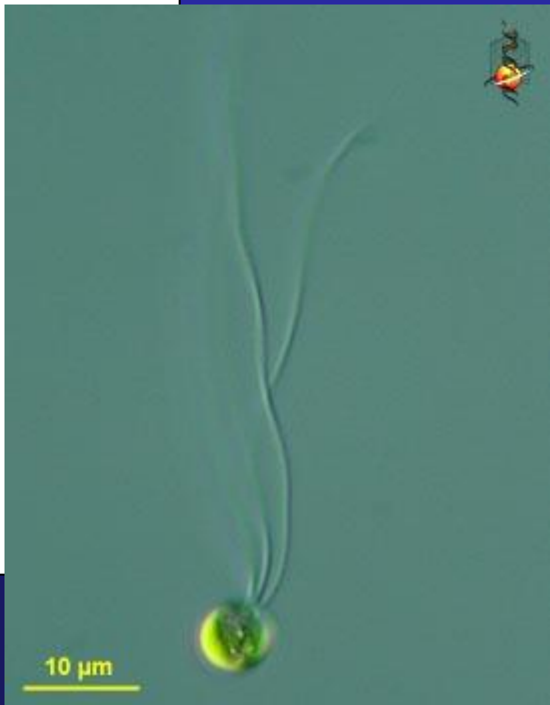
Halosphaera – during spring and early summer, phycomata can accumulate in surface layers (carried by currents and wind) and cause a water blooms – green oily water.

Pyramimonadales



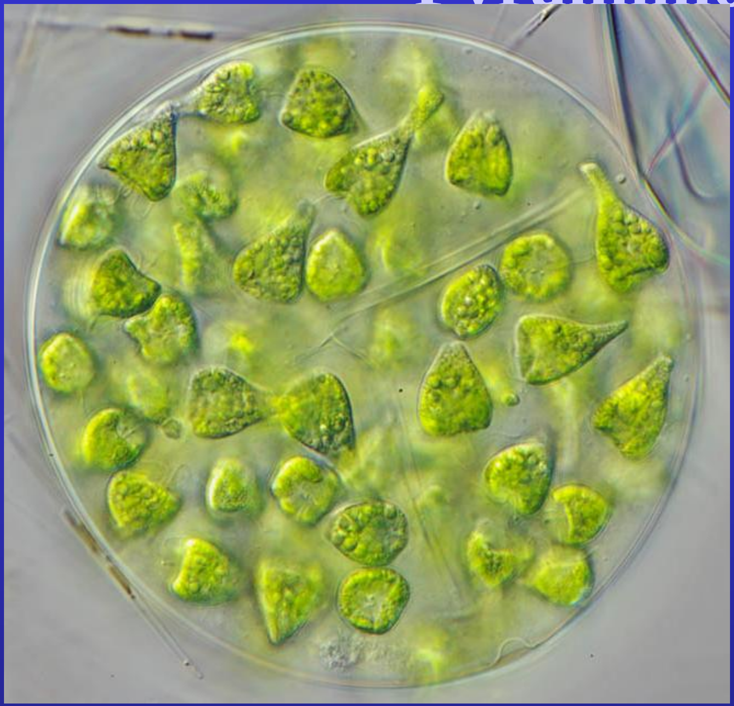
lipids
sporopolenin





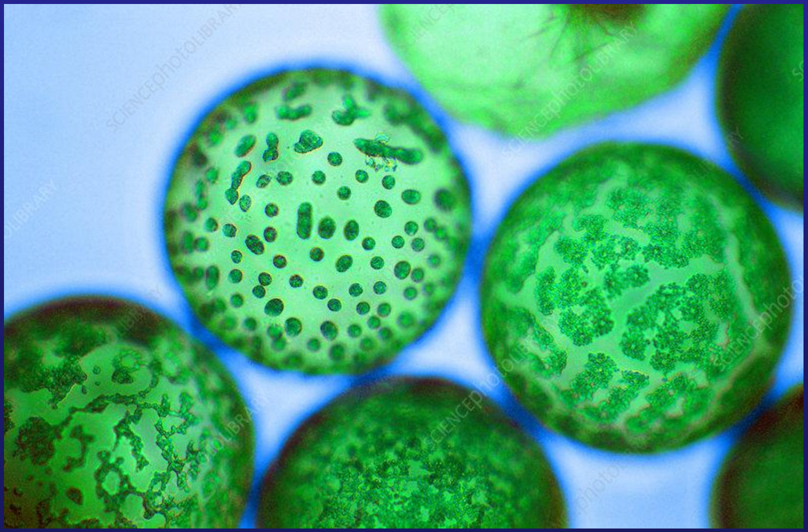
Pterosperma – live cycle

Pyramimonadales



20-30μm

Halosphaera - fagotrophy, mixotrophic nutrition

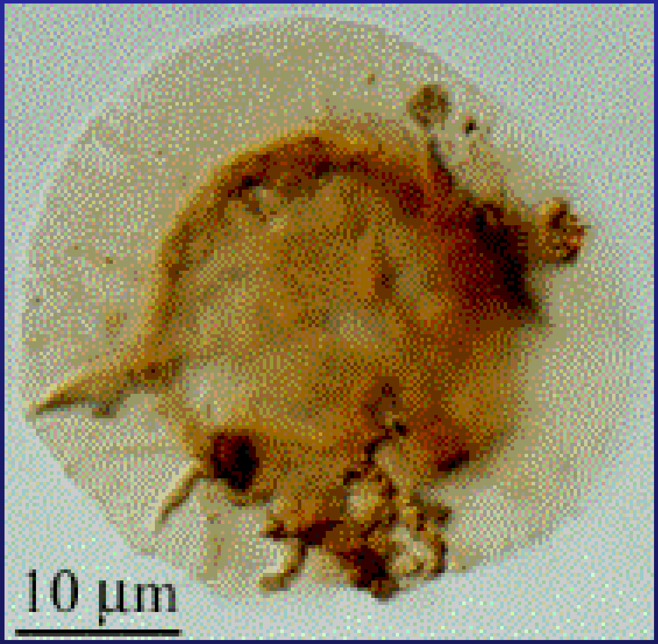


calm winter seas
Phycoma (=asexual cyst)

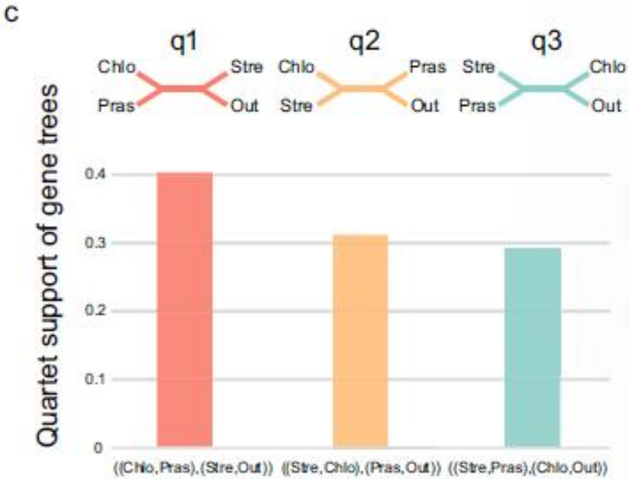
Fossil species

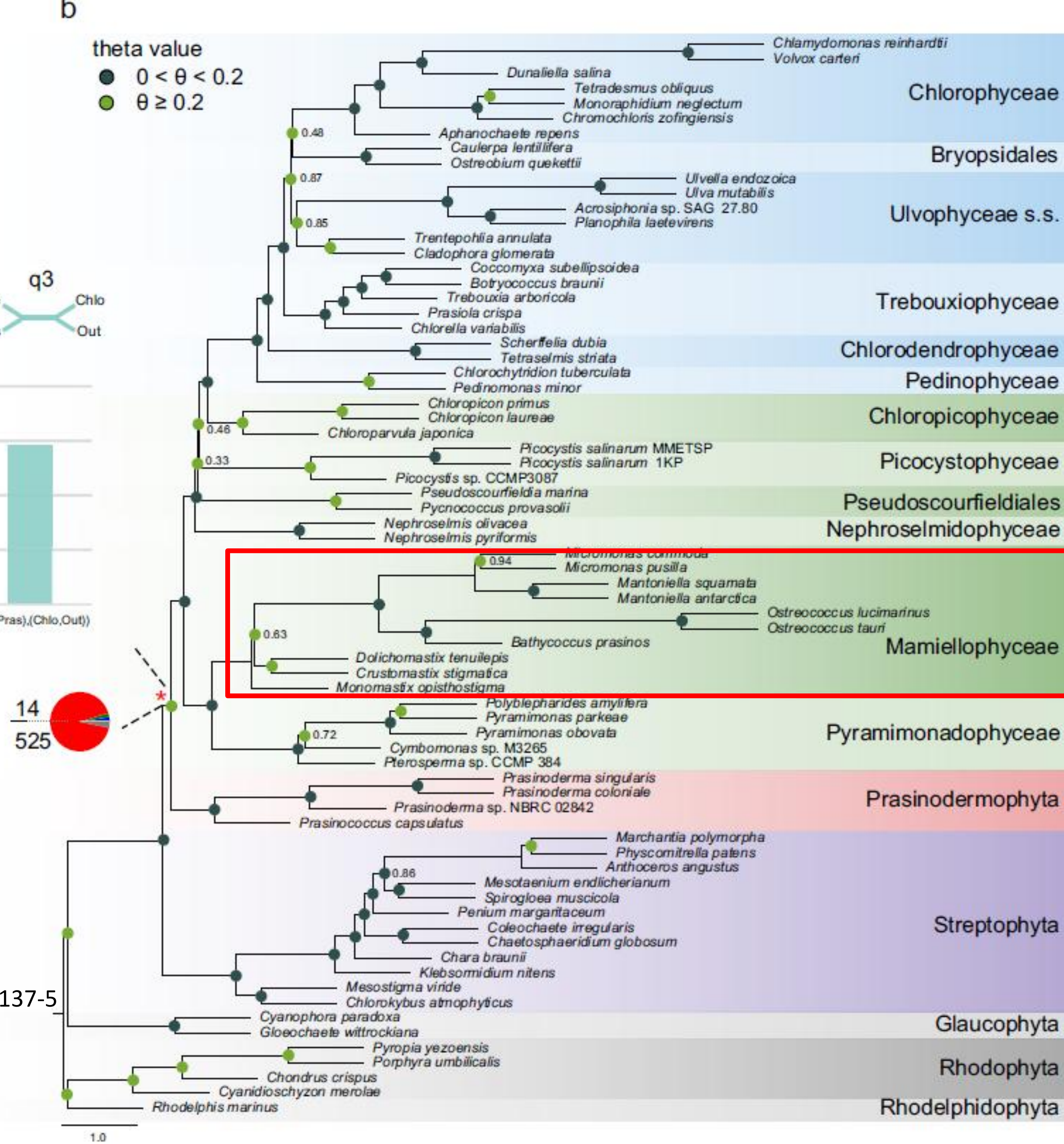
Tasmanites

600 mya - Precambrium



Pterospermella

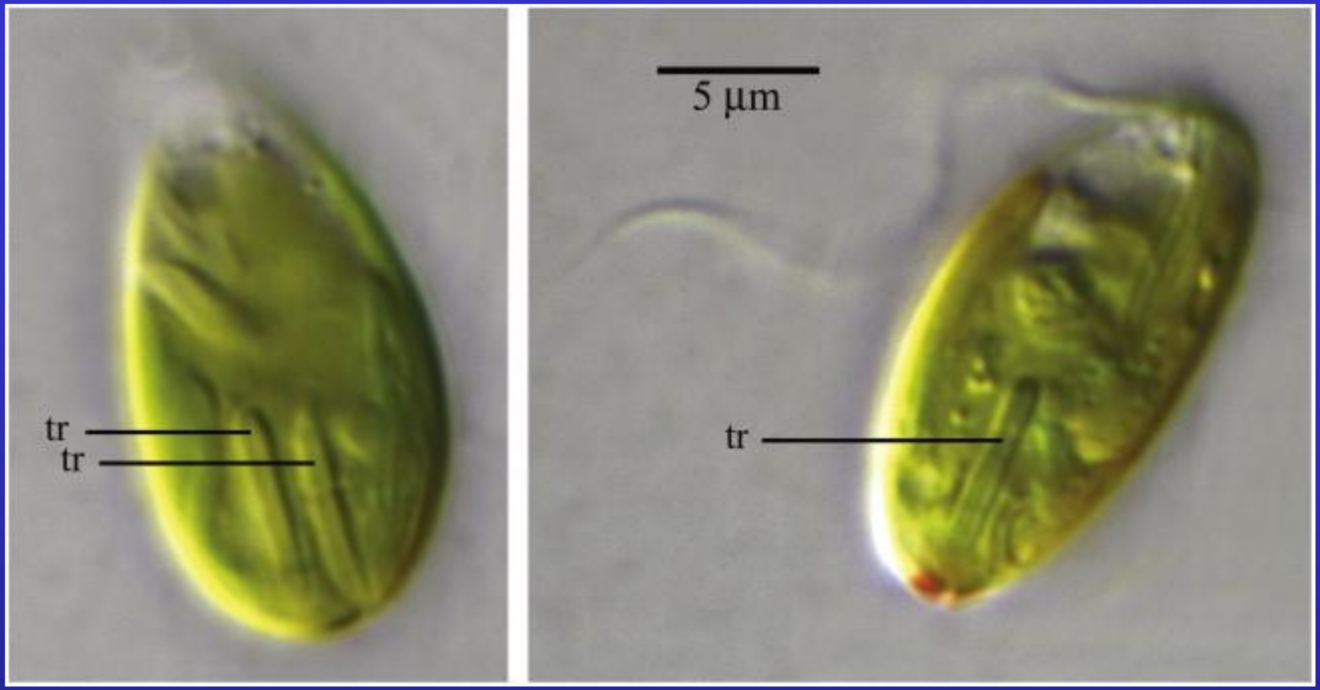




Yang et al. 2023

https://doi.org/10.1038/s41467-023-41137-5

Monomastigales



trychocysts= ejectosomes

Light micrographs of *Monomastix opisthostigma*

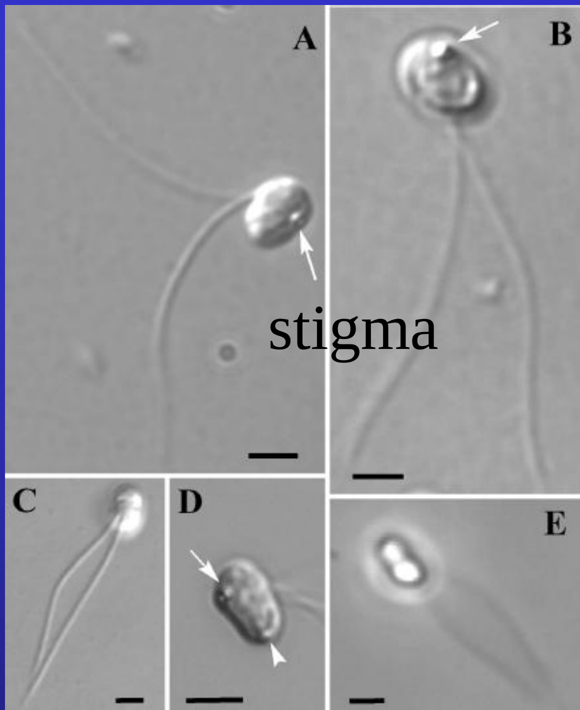
basal lineage – large cells up to 20 µm

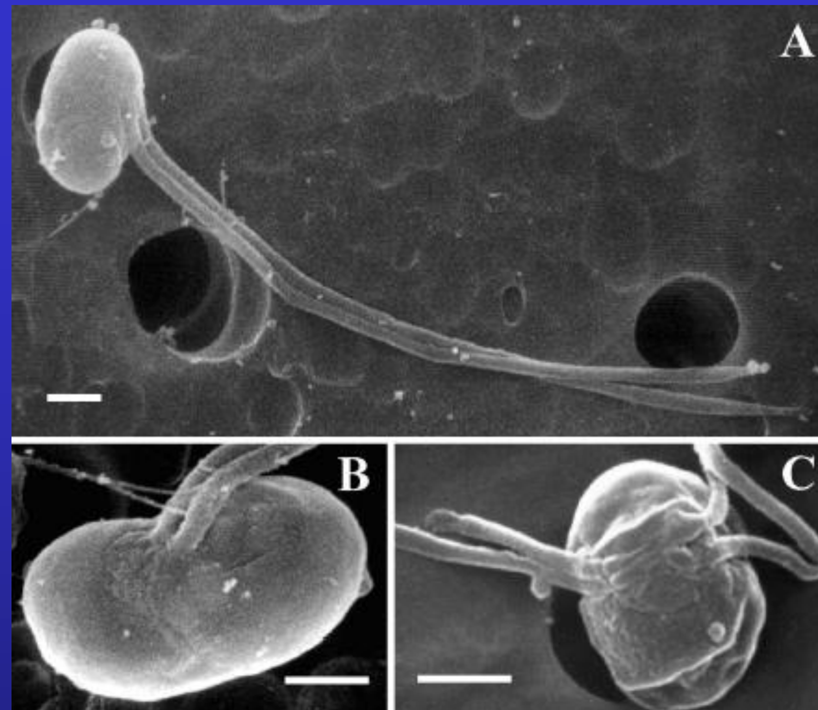
Dolichomastigales and the Mamiellales cells are usually no longer than 5 µm and in two lineages (Bathycoccaceae and *Micromonas*) are reduced to the size of the smallest eukaryotes (1 µm; Courties et al. 1994). Cell size reduction is accompanied by loss of the flagellar apparatus and eyespot (Bathycoccaceae) and/or the scaly covering (*Ostreococcus* and *Micromonas*).

Dolichomastigales

Crustomastix stigmatica

Zingone et al.2002

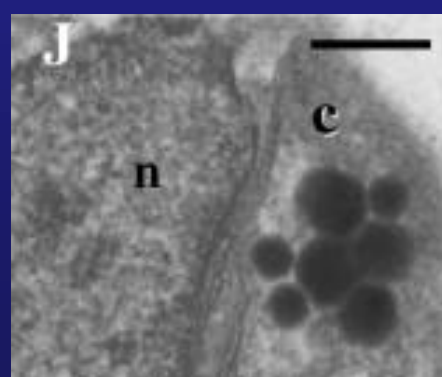




3-5 µm, scales on long flagella, stigma; isolated from Mediterranean Sea

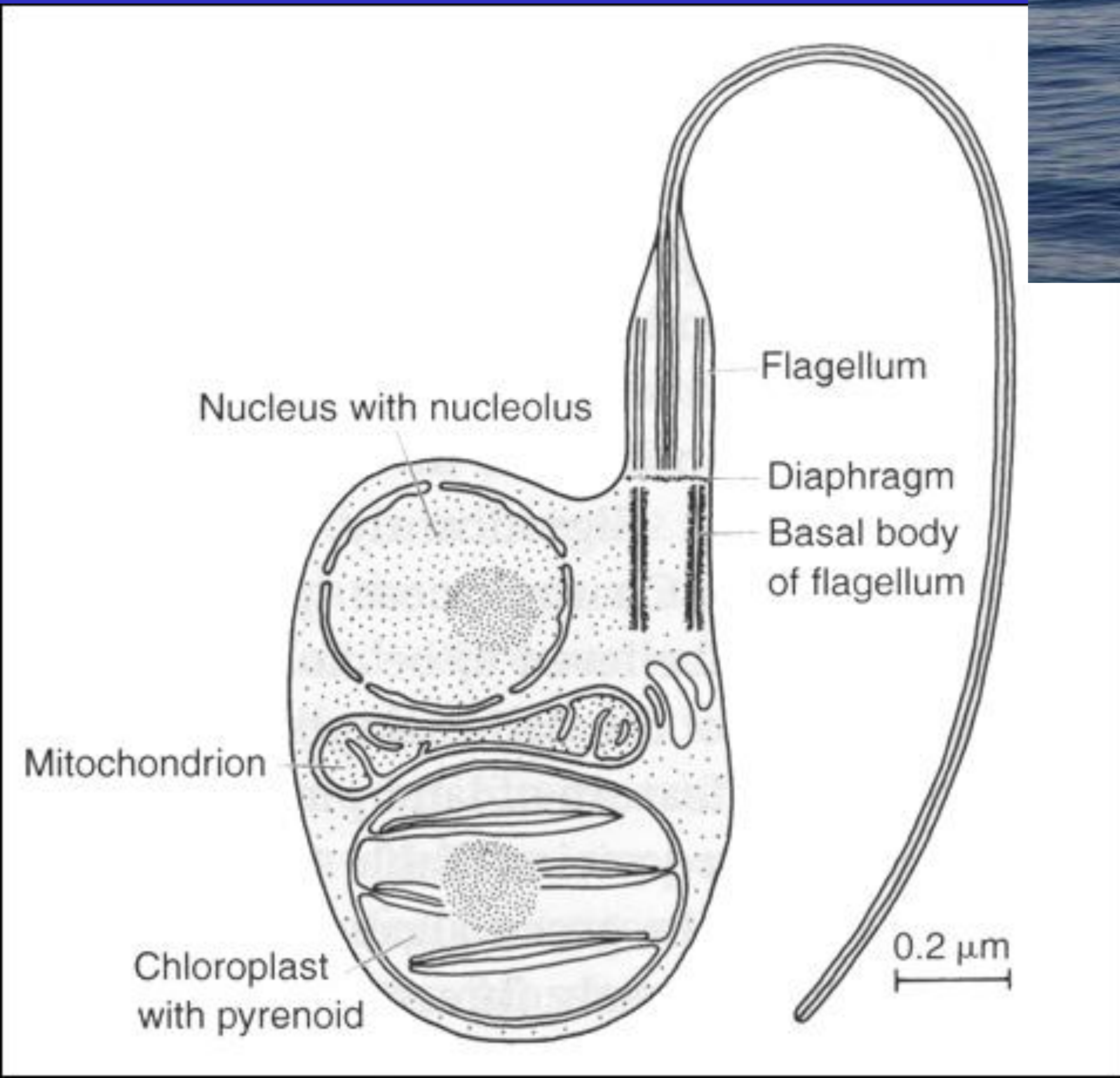
dividing cells

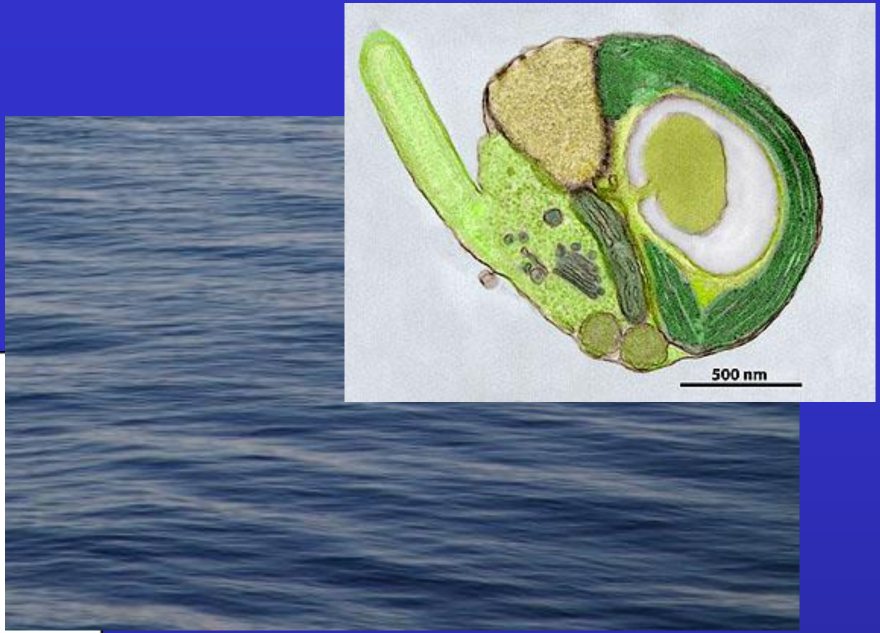
No flat scales



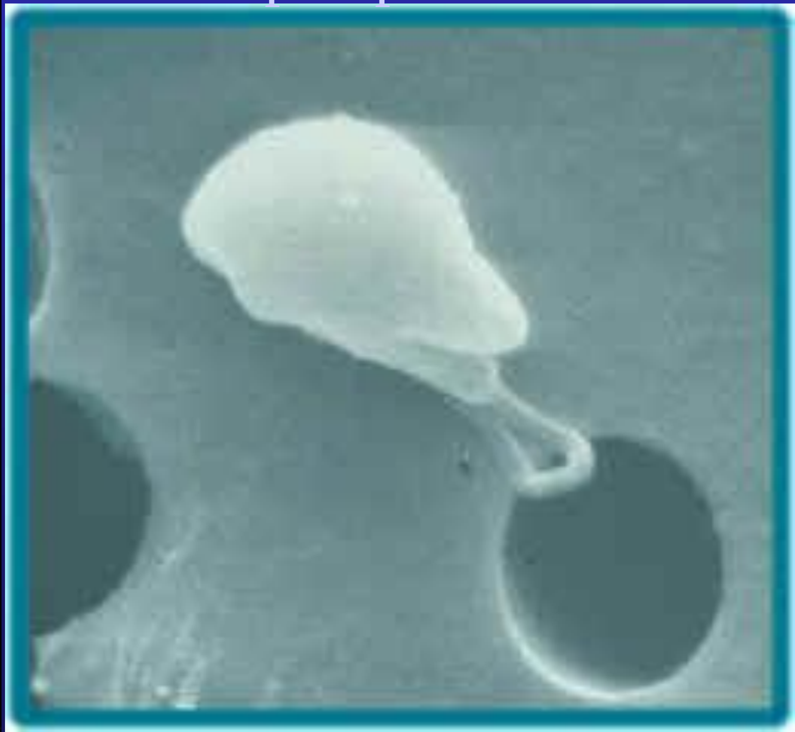
Mamiellales

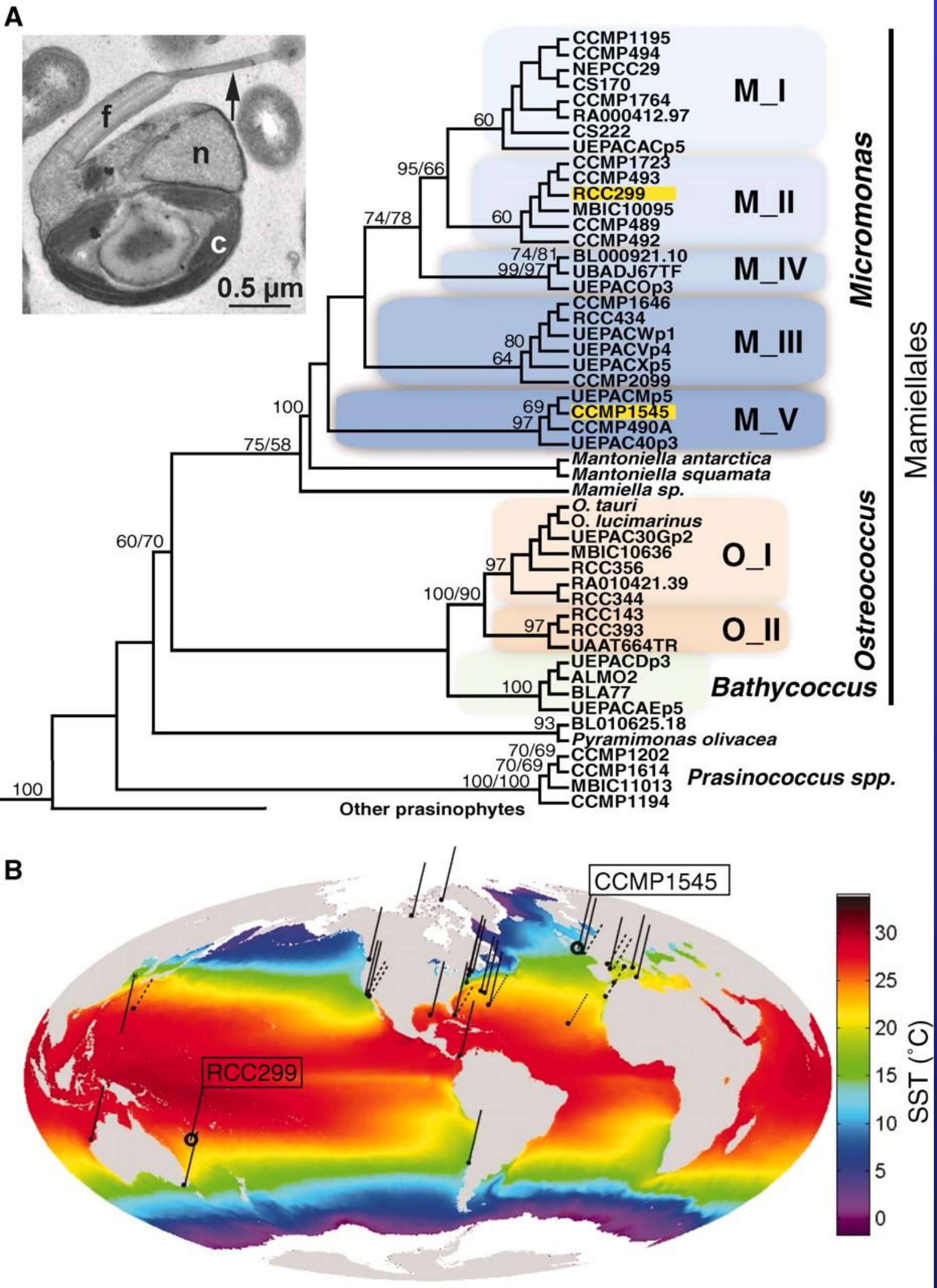
Micromonas pusilla –
without scales





oceanic picoplankton



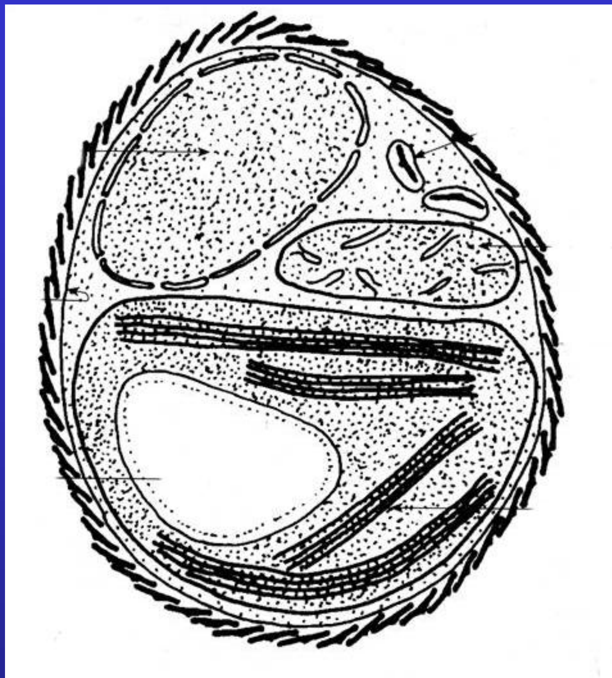


Micromonas phylogeny and distribution NJ tree. (**B**) Mean sea surface temperature (SST) for 2006 measured with global high-resolution SST (GHRSST) blended infrared and microwave SSTs, and locations where *Micromonas* (solid lines and circles around the isolates used in this work) and *Ostreococcus* (dashed lines) 18*S* rDNA sequences have been recovered.

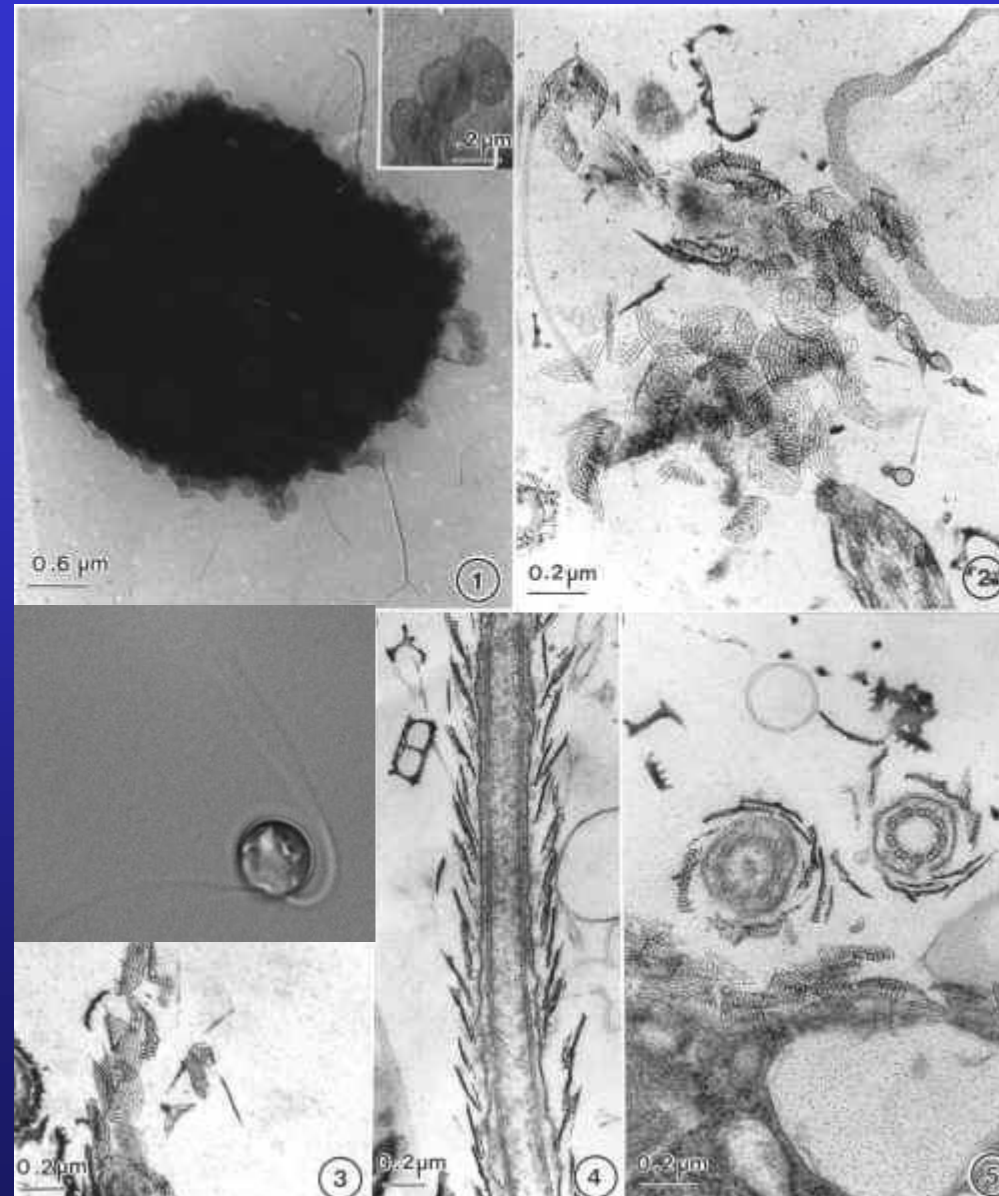
***Micromonas* appeared in all temperature regimes**.

Worden *et al. 2009*

Mamiellophyceae

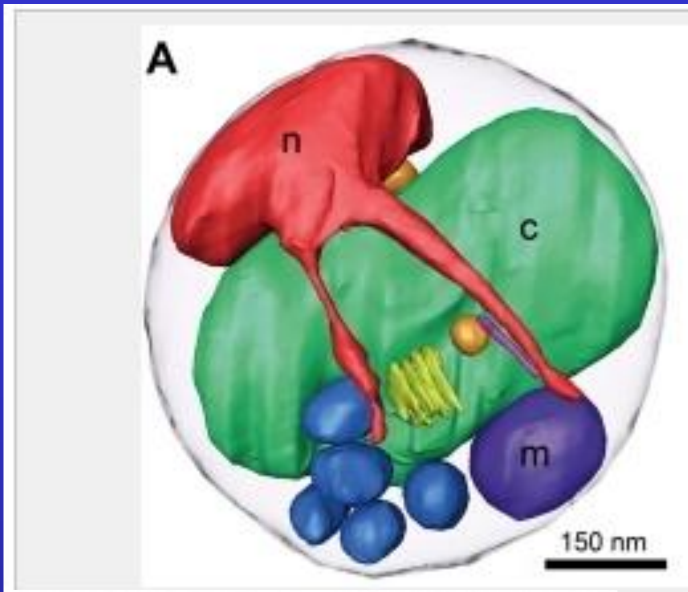


Bathycoccus – lost of flagellum
North Atlantic



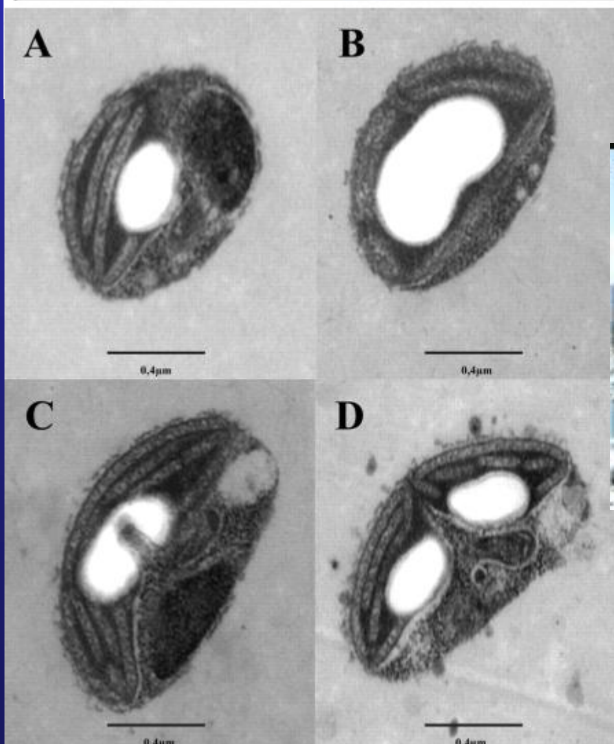
Mamiella gilva

Mamiellales

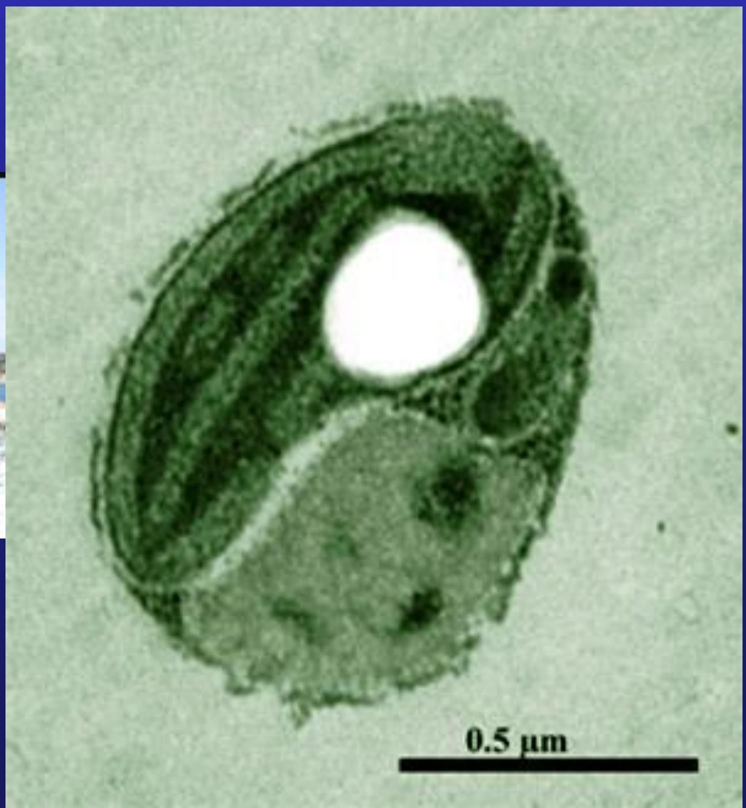


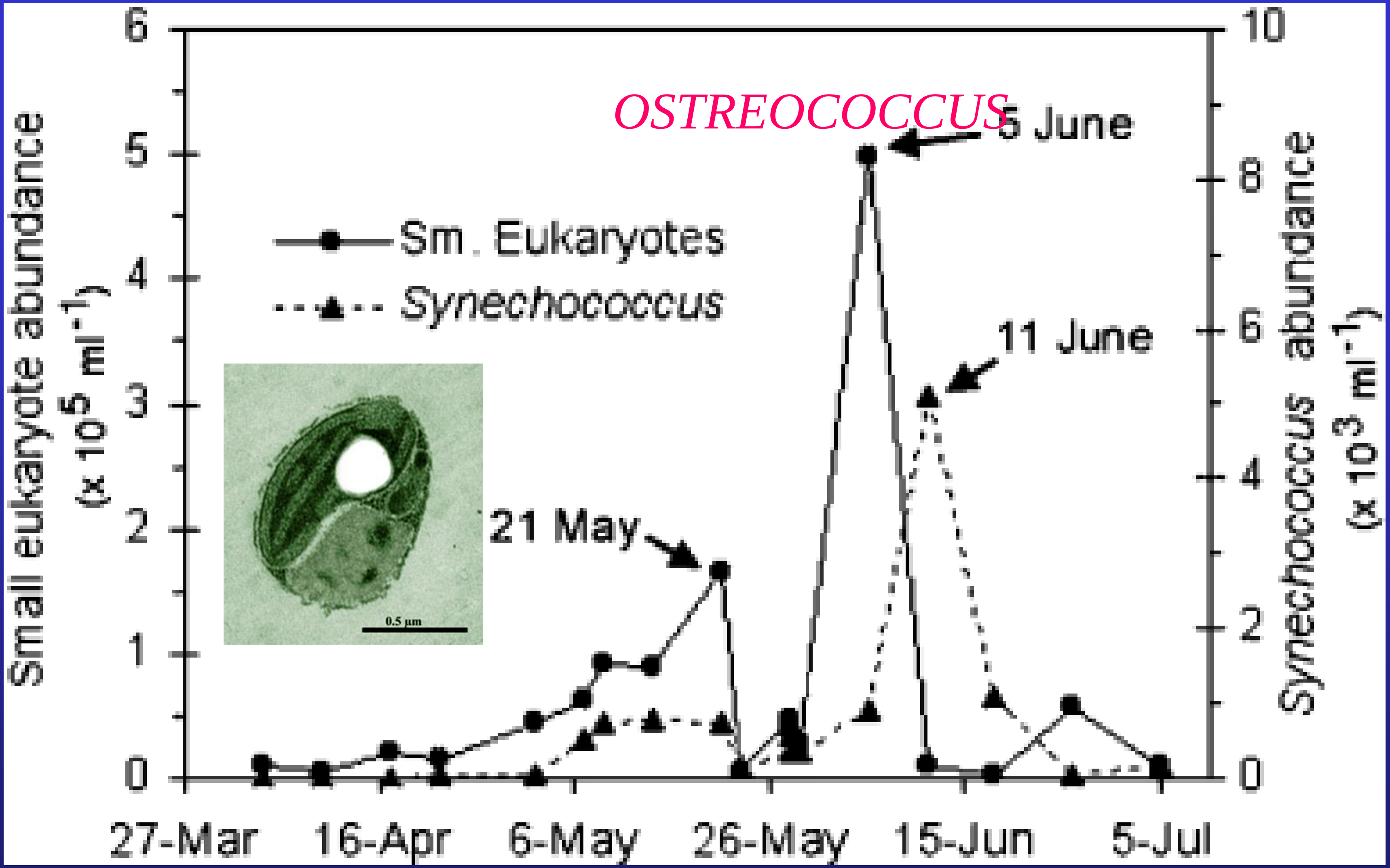
Ostreococcus belongs to the is reported as a globally abundant, single-celled alga thriving in the upper (illuminated) water column of the oceans.

Blooms in the sea, the smallest eukaryotic genom (12 Mbp) – densely packed genom

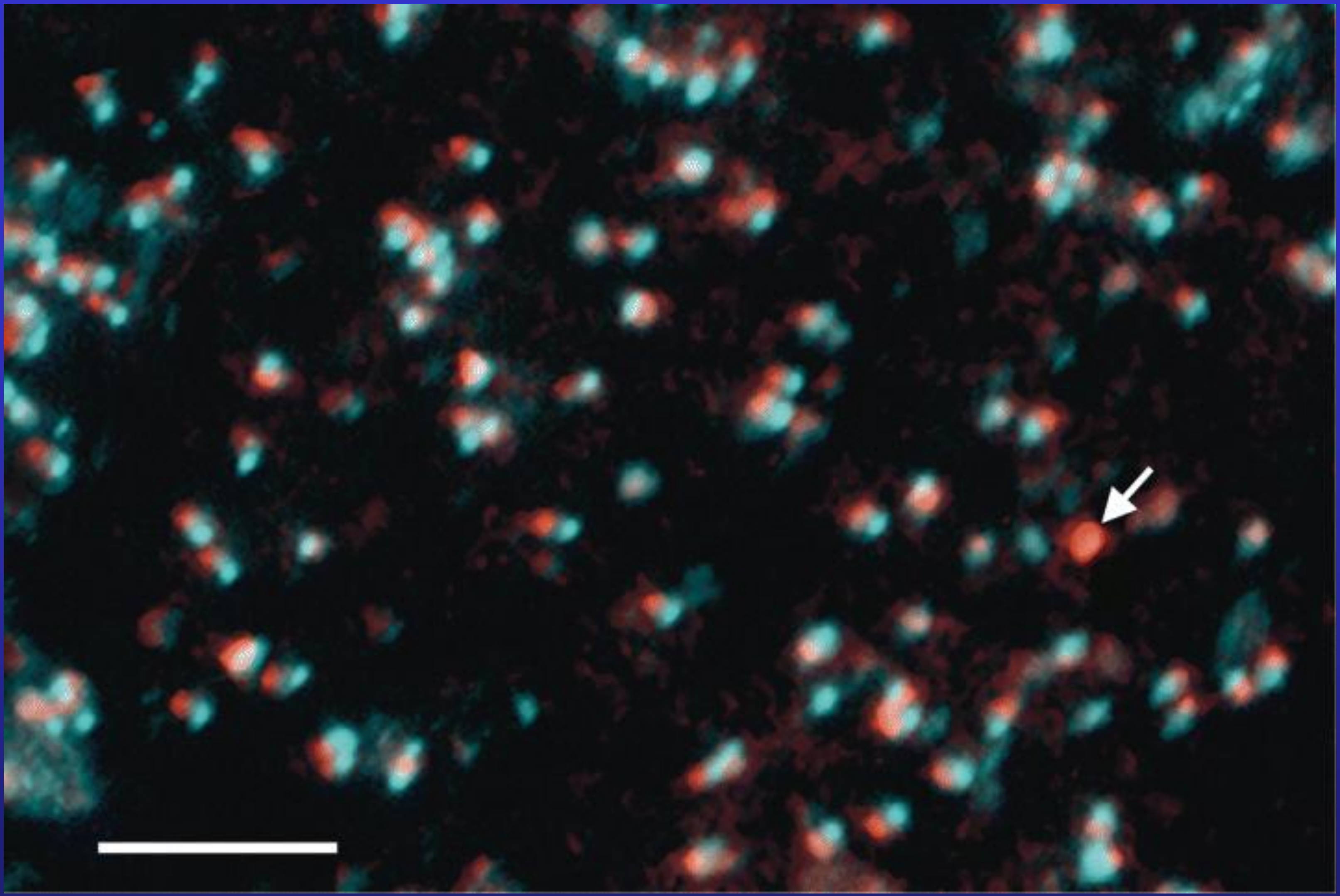


diploid human g. 6.27 Gbp





1. Abundances of small eukaryotes and *Synechococcus* cells over the 2001 study period in West Neck Bay, New York as counted by flow cytometry. Major bloom events are indicated. Note difference in scales.



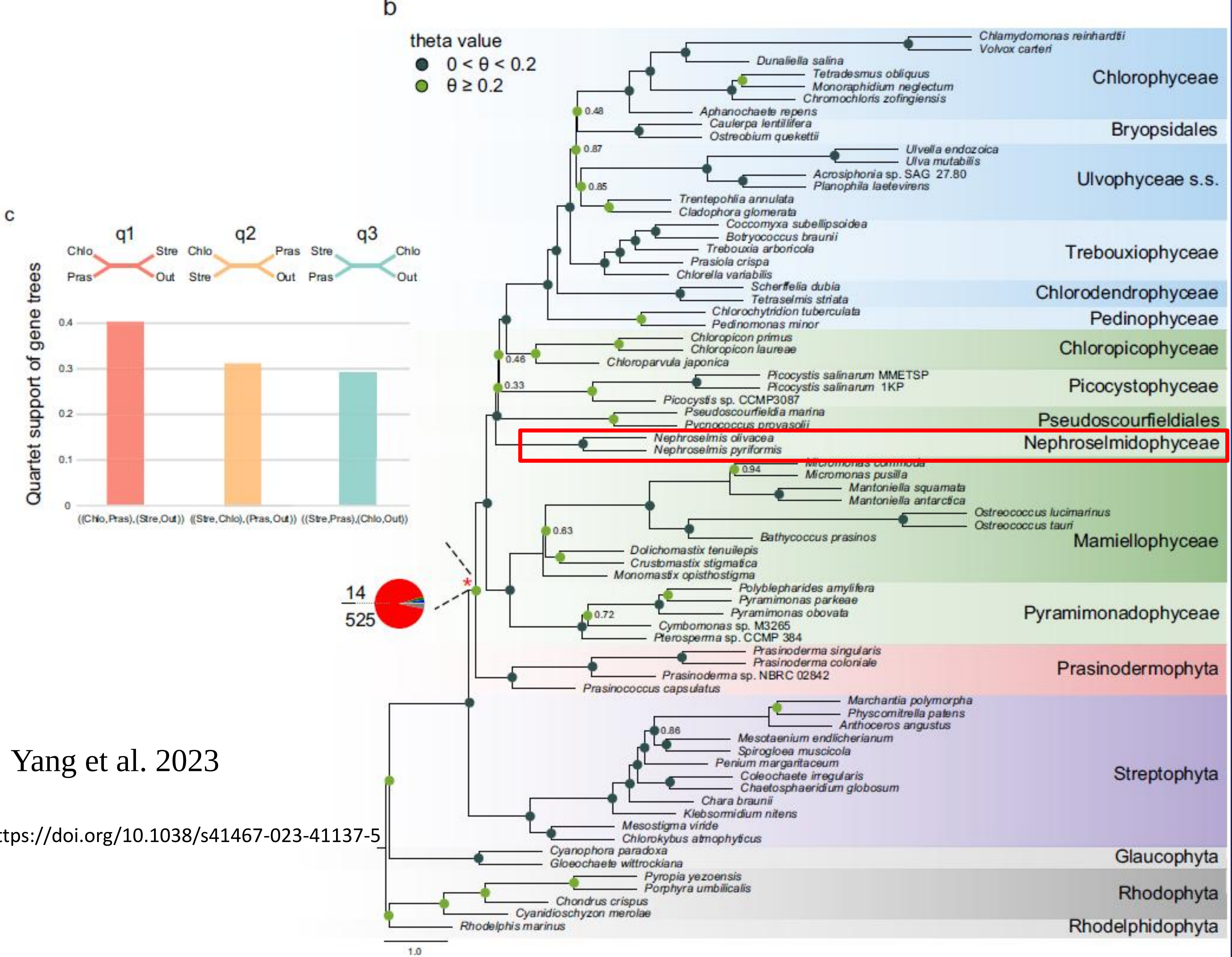
Color composite epifluorescence micrograph showing DAPI-stained *Ostreococcus*-like cells with nuclei (cyan) and chloroplasts (red autofluorescence). A single *Synechococcus* cell (arrow) is also present. Scale bar, 10 μm.

O'Kelly et al. 2003

Mamiellophyceae

Do they reproduced sexually???

Ostreococcus as well as *Micromonas* may contain meiotic genes and thus reproduce sexually (Derelle et al. 2006; Worden et al. 2009), but experimental proof for sexual reproduction in the Mamiellophyceae is still lacking.



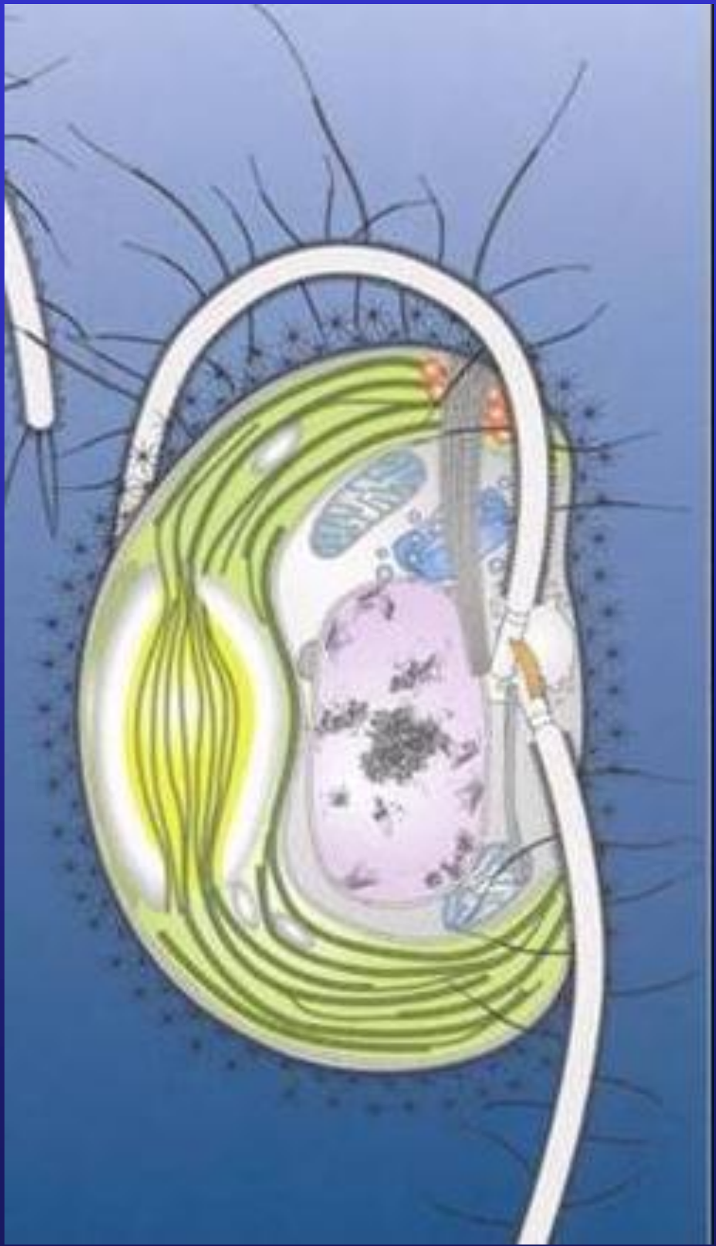
Yang et al. 2023

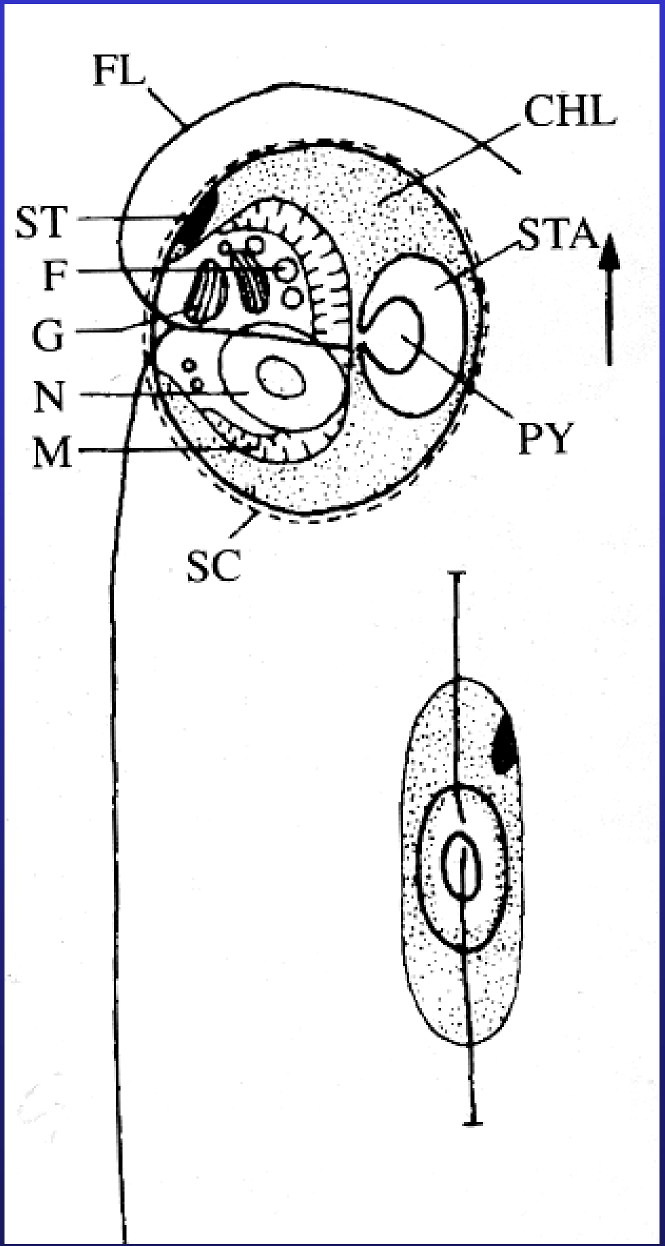
https://doi.org/10.1038/s41467-023-41137-5

Nephroselmidophyceae

Nephroselmis

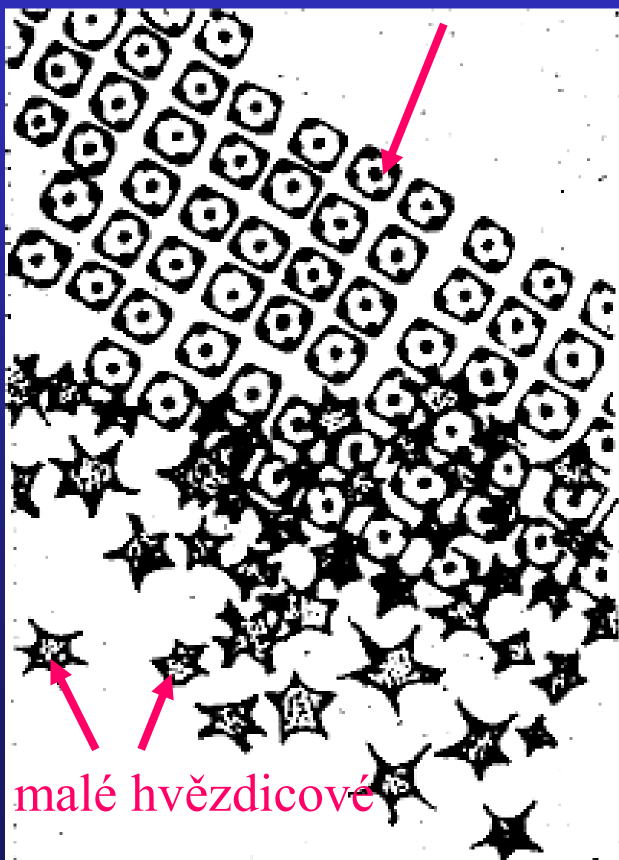
swiming

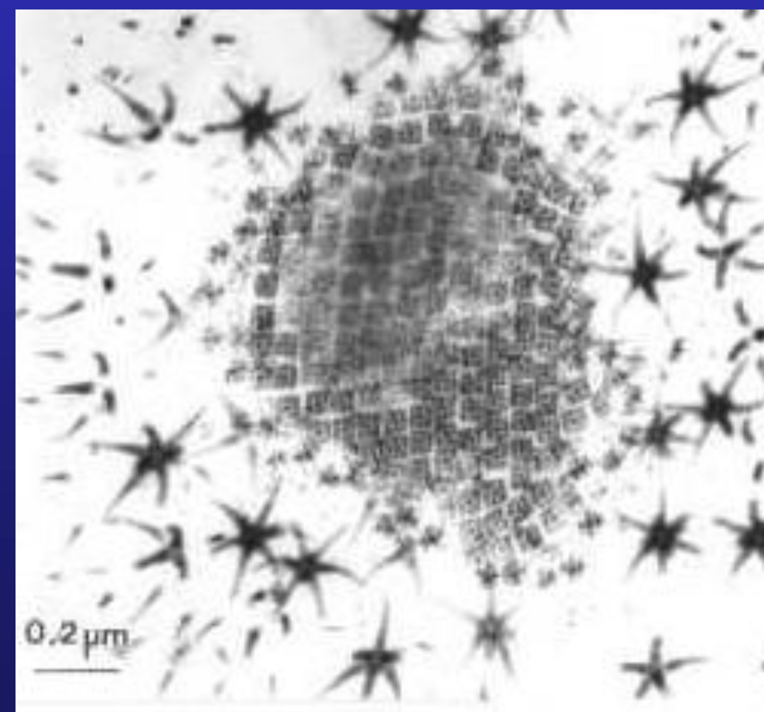




Organic scales

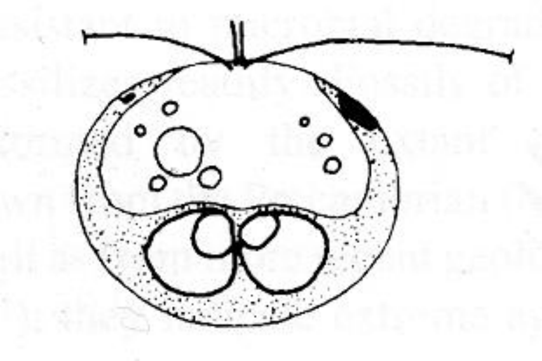
Nephroselmis

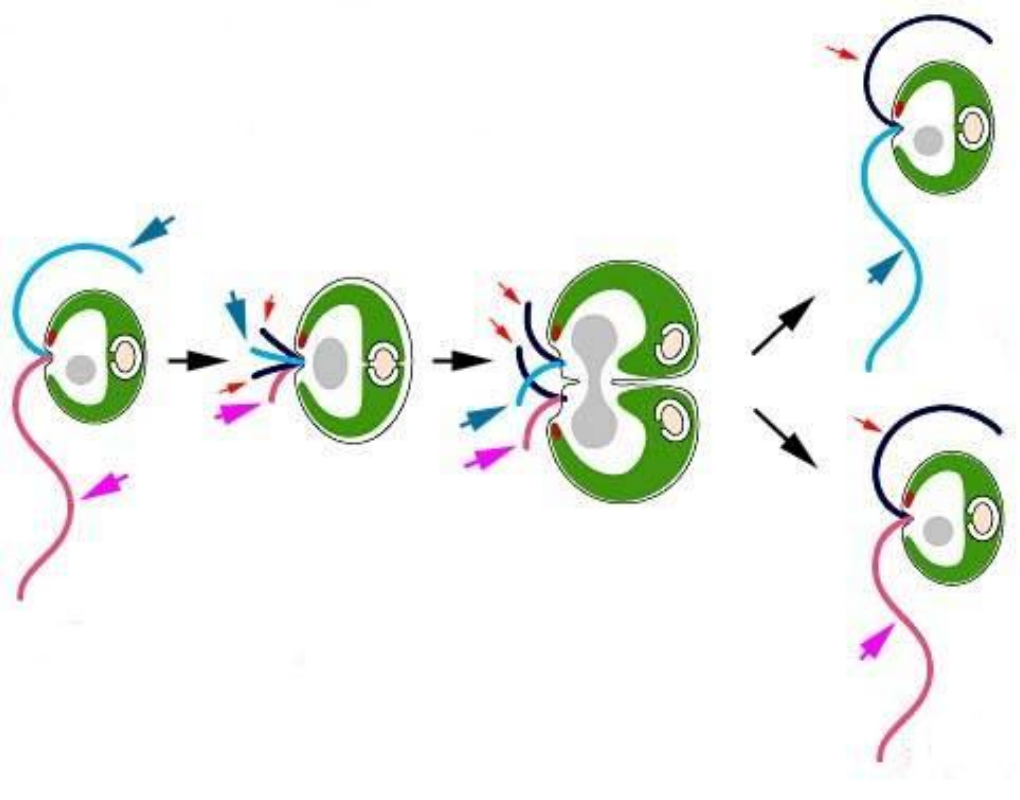




Mitosis and cytokinesis

- schizotomy

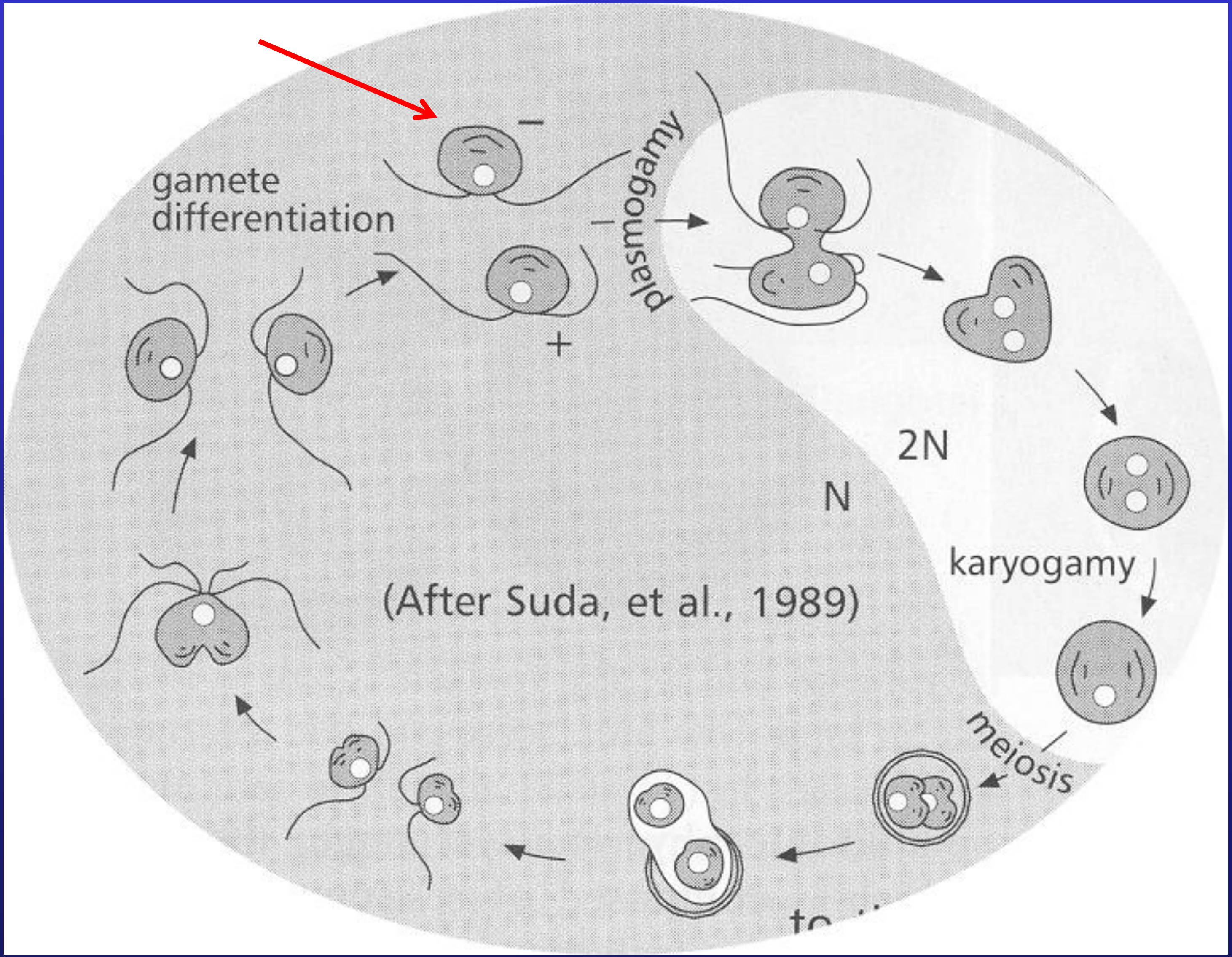




Nephroselmis rotunda

Sexual reproduction

Haplontic life cycle, izogamy, heterothalism



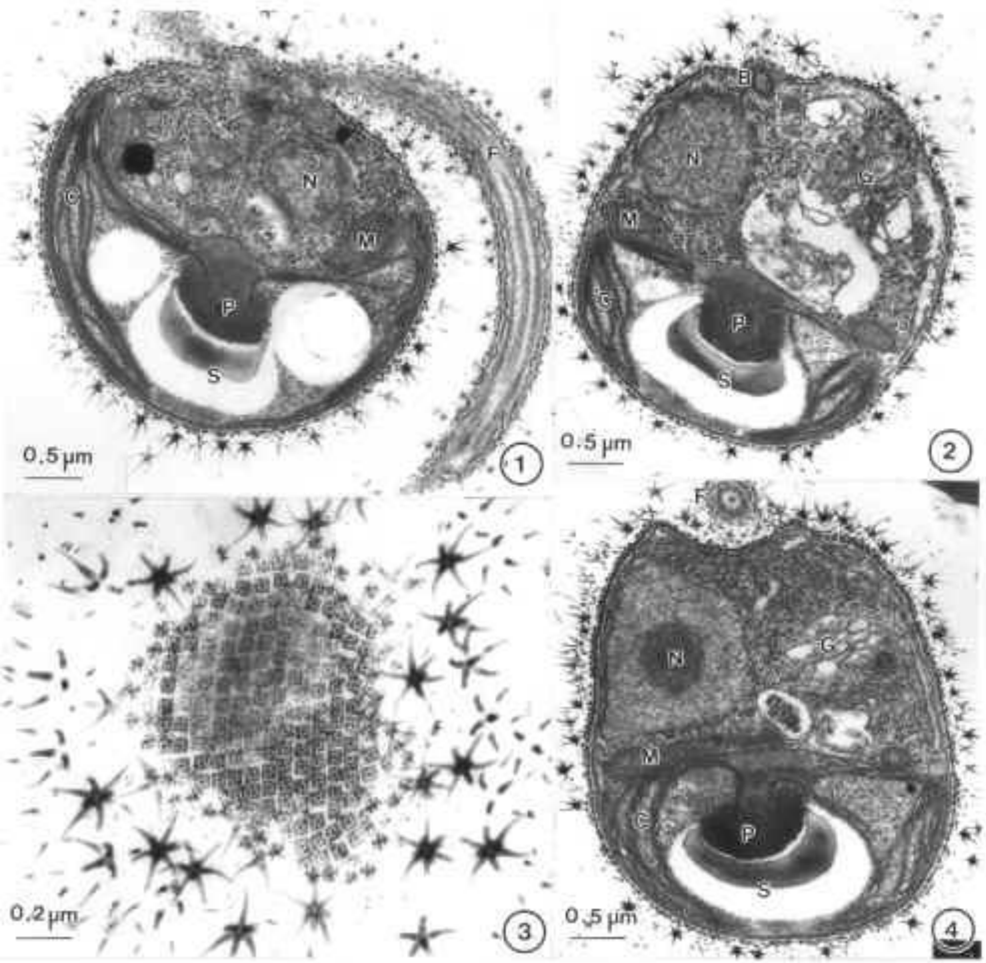
Nephroselmis olivacea

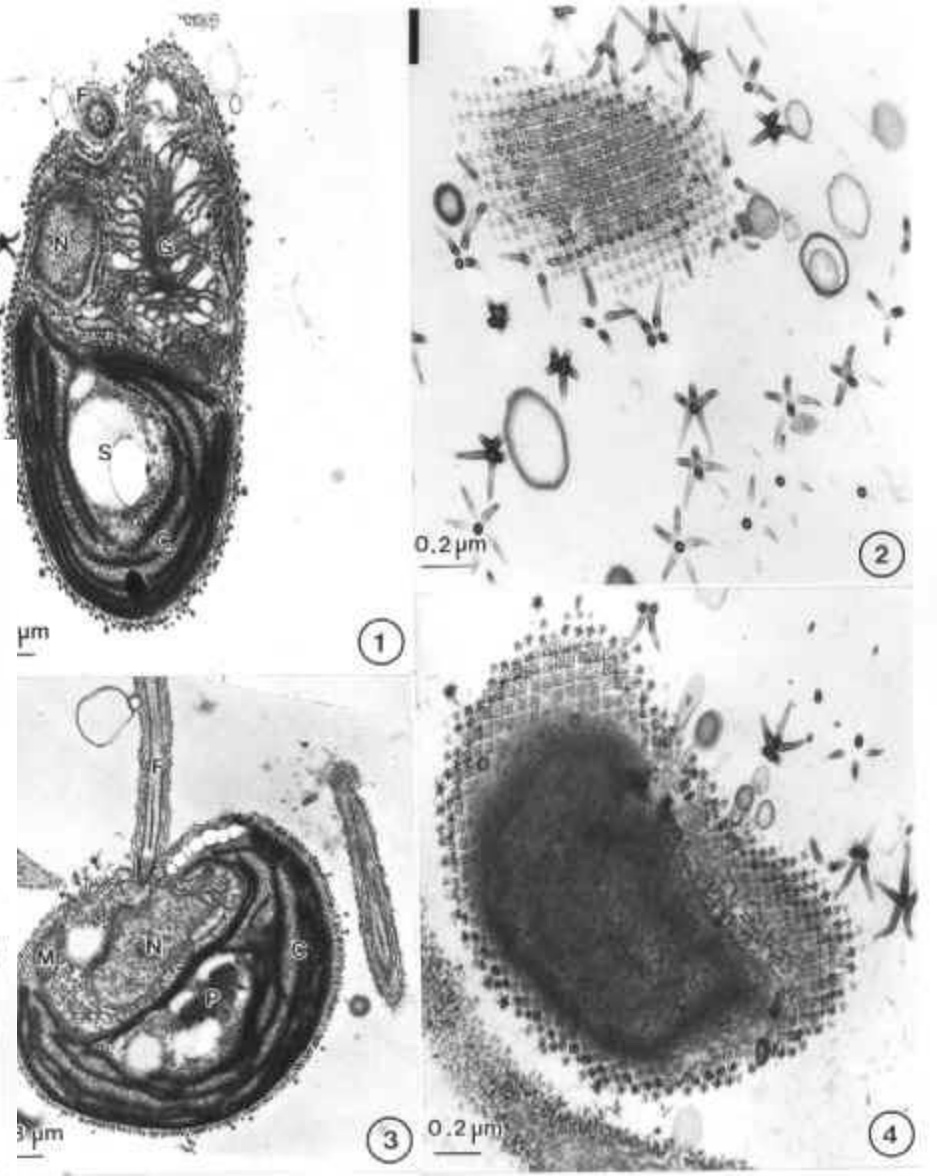
Nephroselmis - ultrastructure

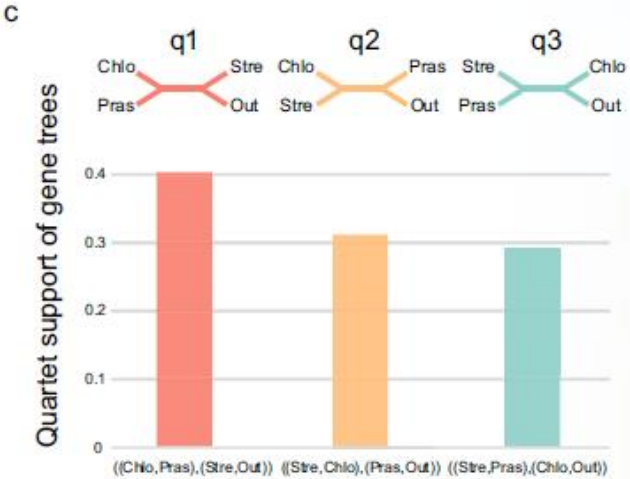
malé čtvercové

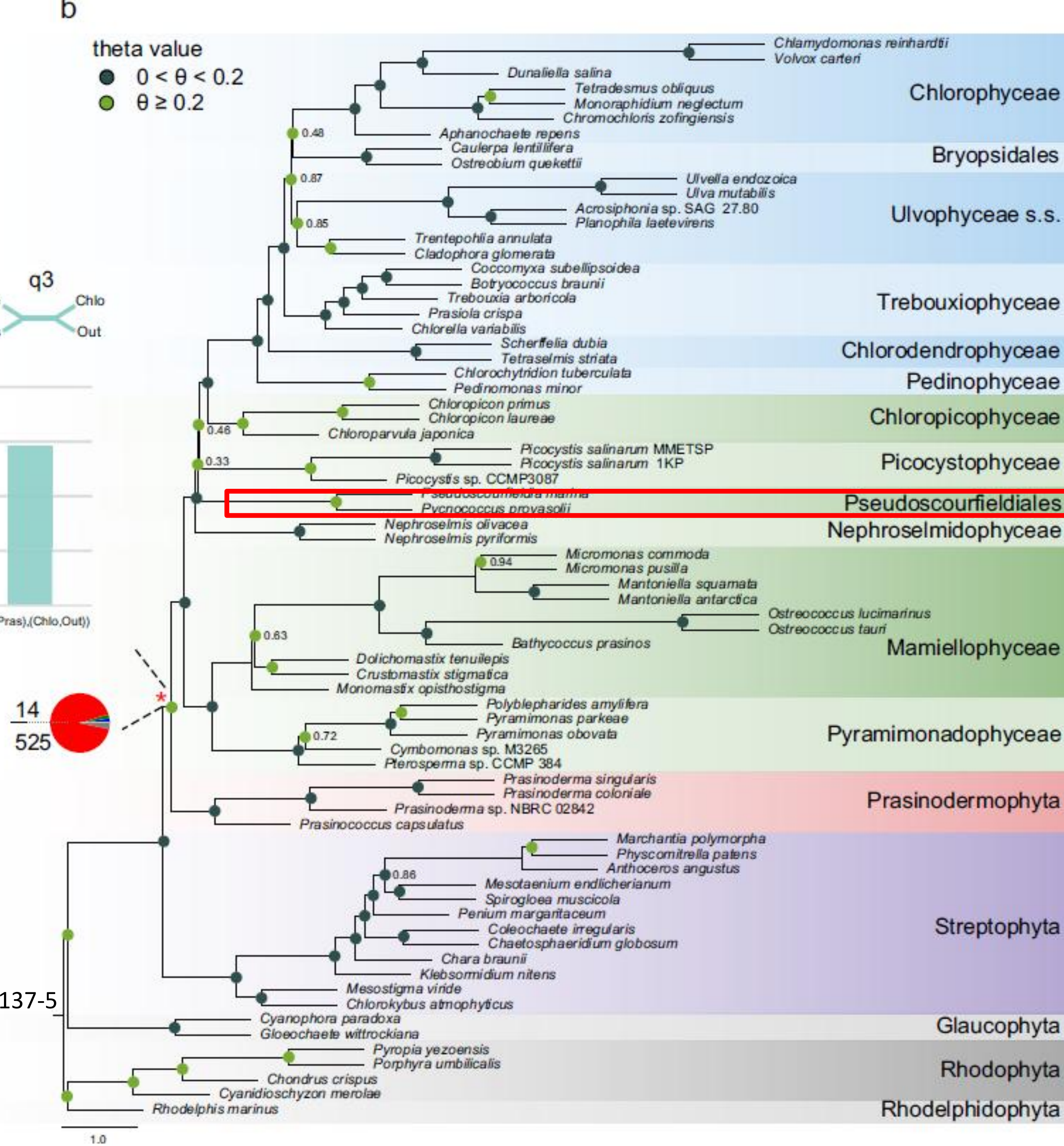
malé hvězdicové

velké hvězdicové





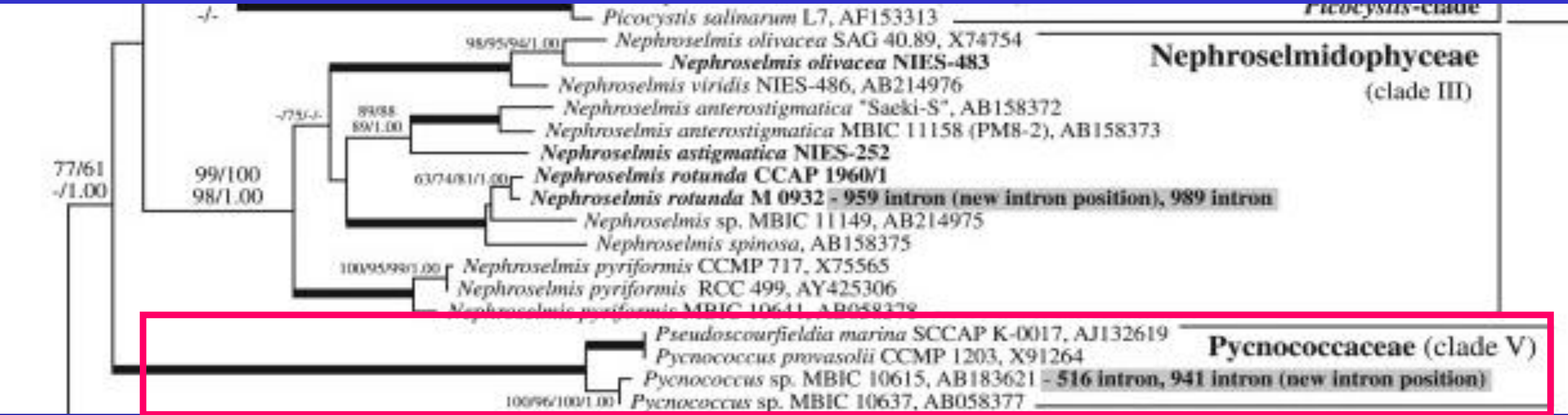




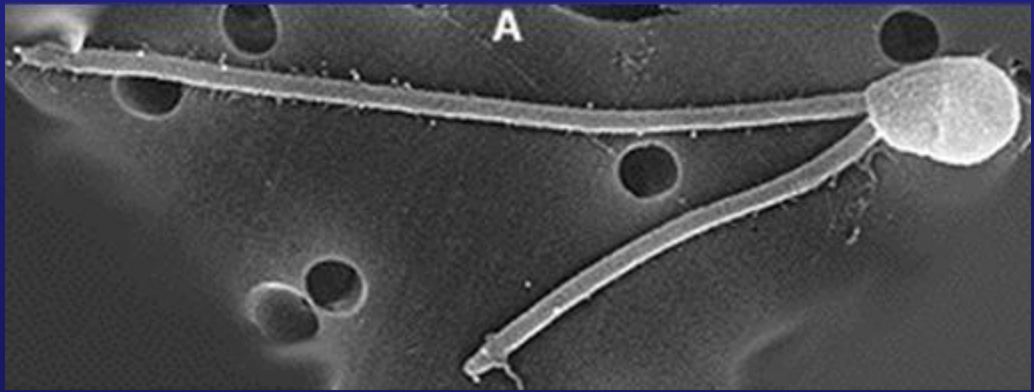
Yang et al. 2023

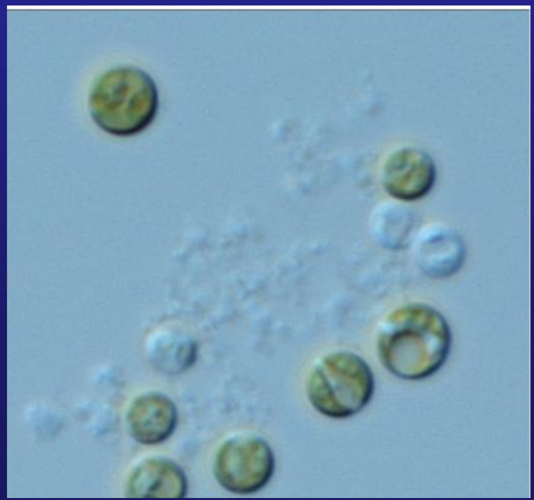
https://doi.org/10.1038/s41467-023-41137-5

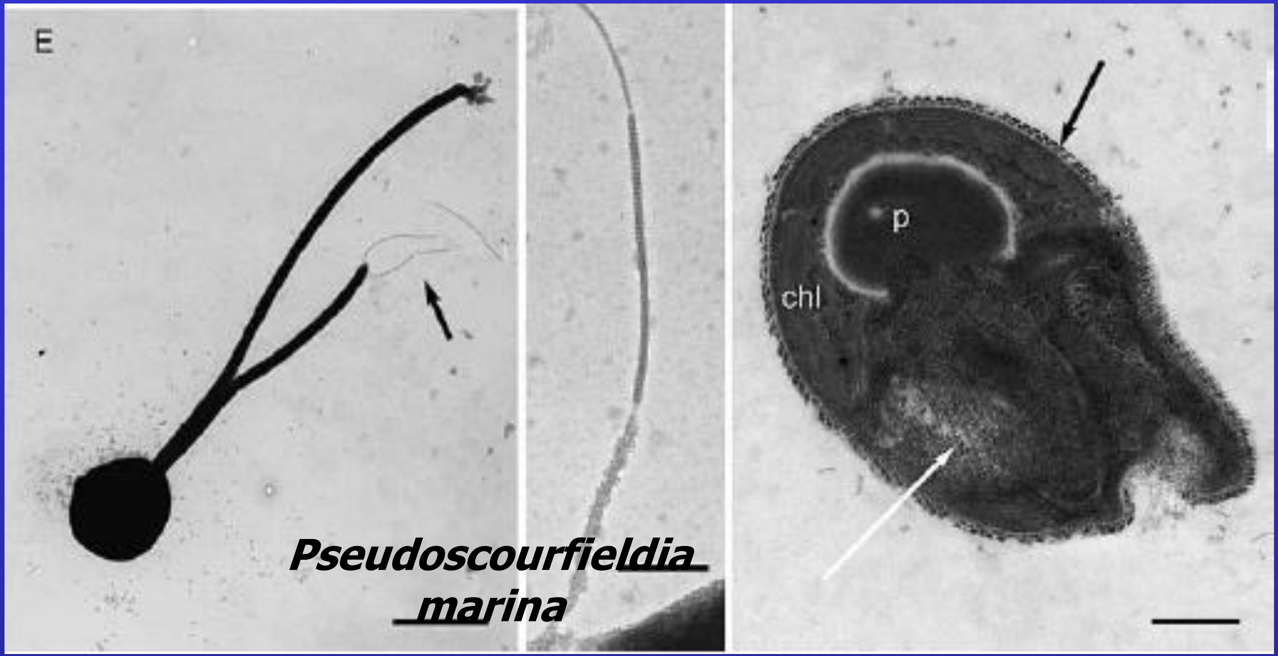
Pseudoscourfieldiales

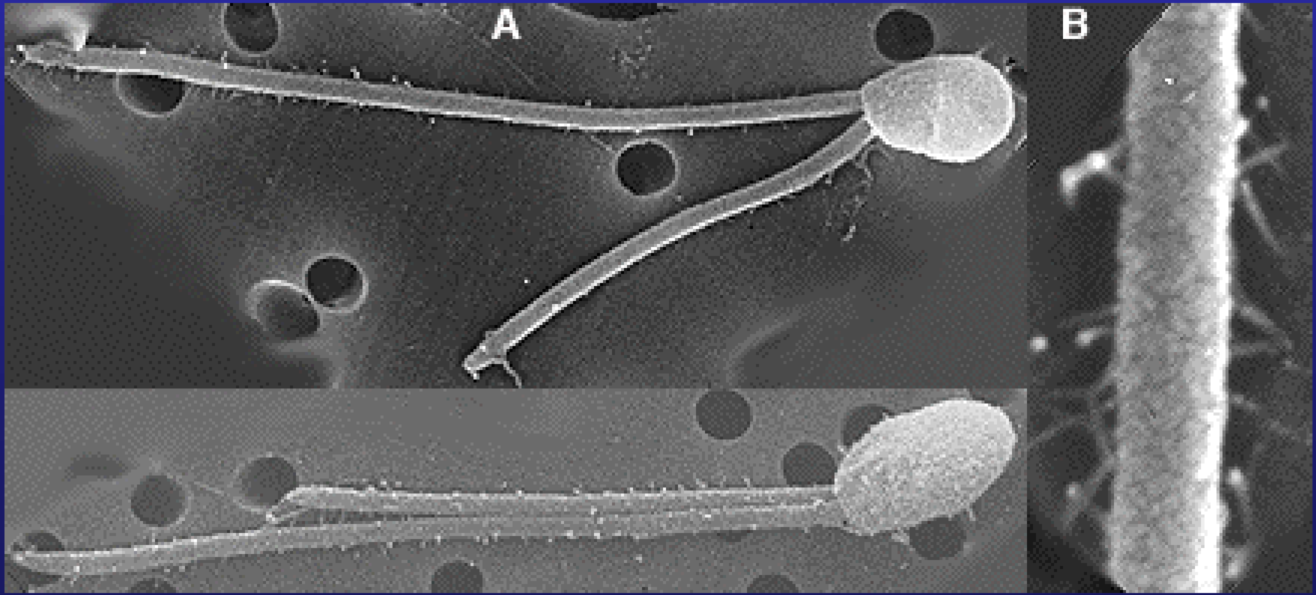


Pseudoscourfieldia marina and *Picnococcus provasolii* are genetically identical and presumably represent different life history stages of a single taxon; unpubl.

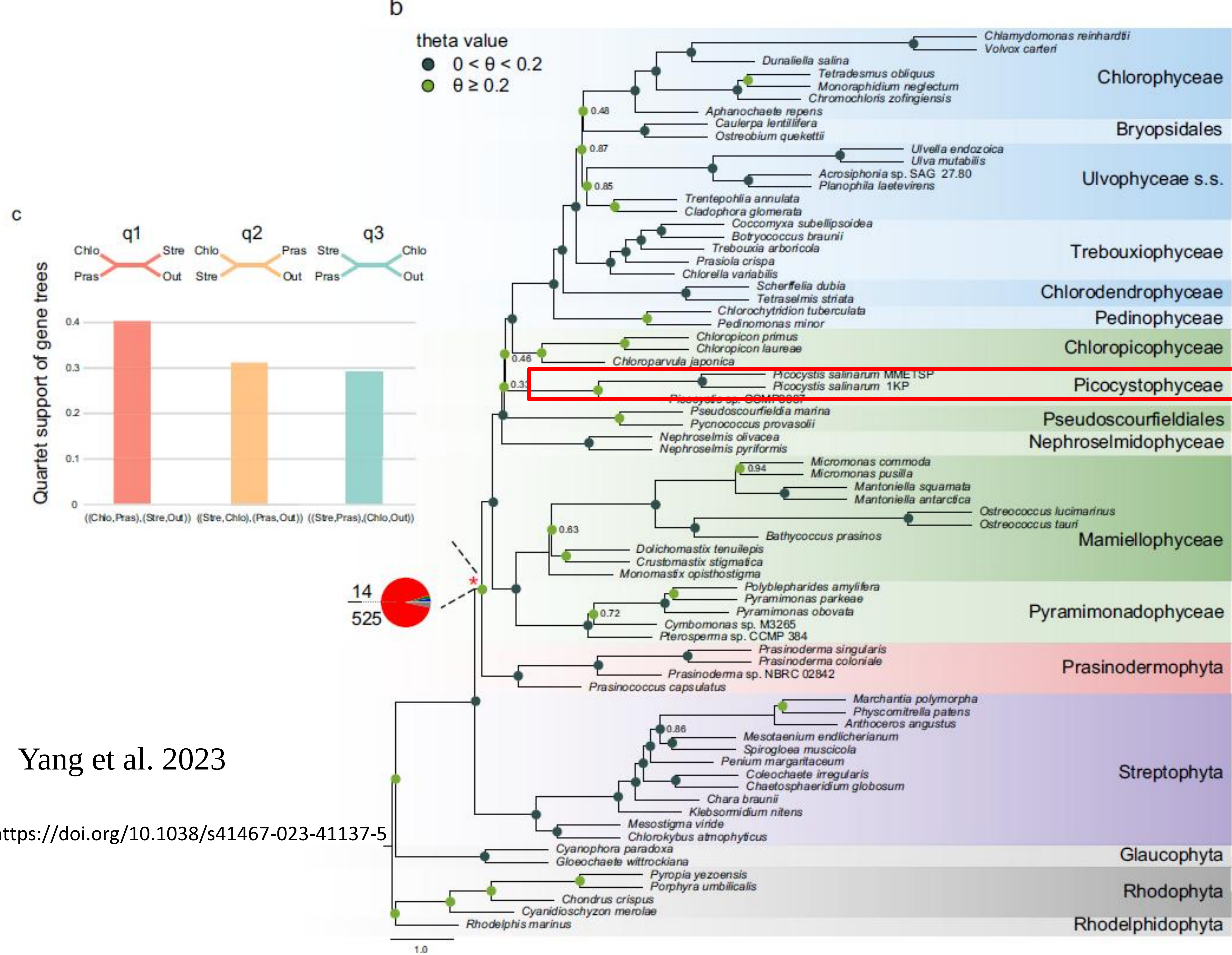








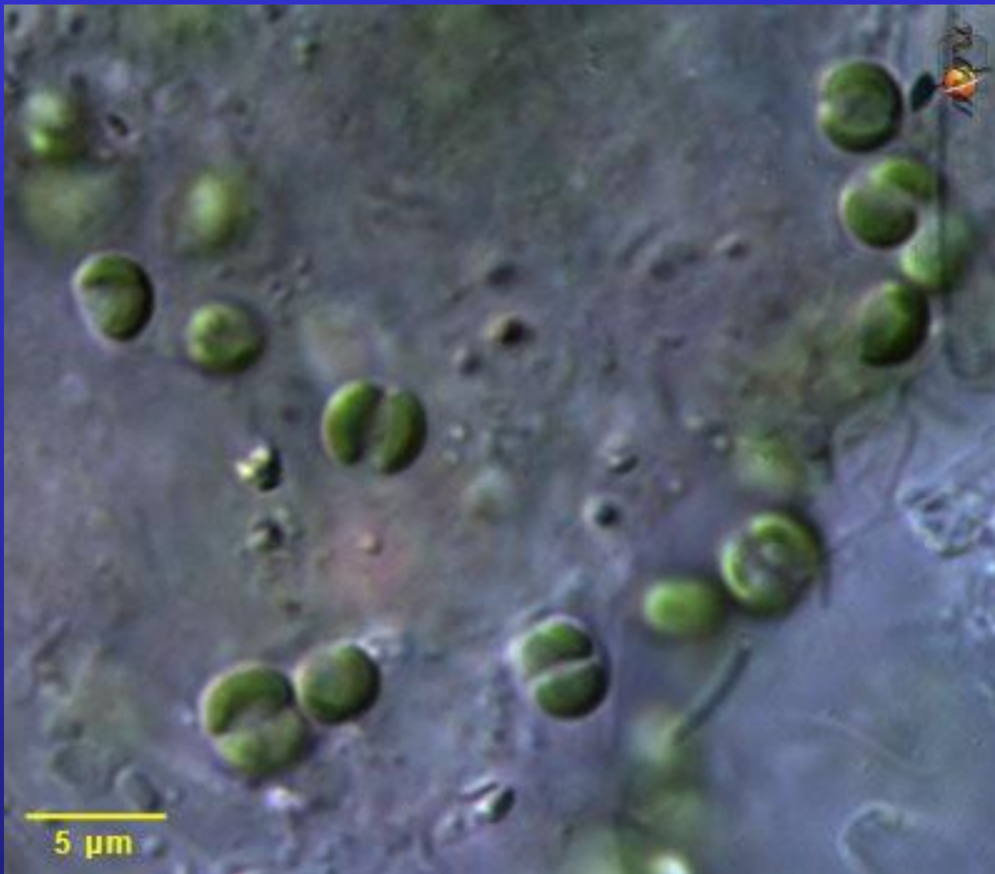
Guillou et al. 2004



Yang et al. 2023

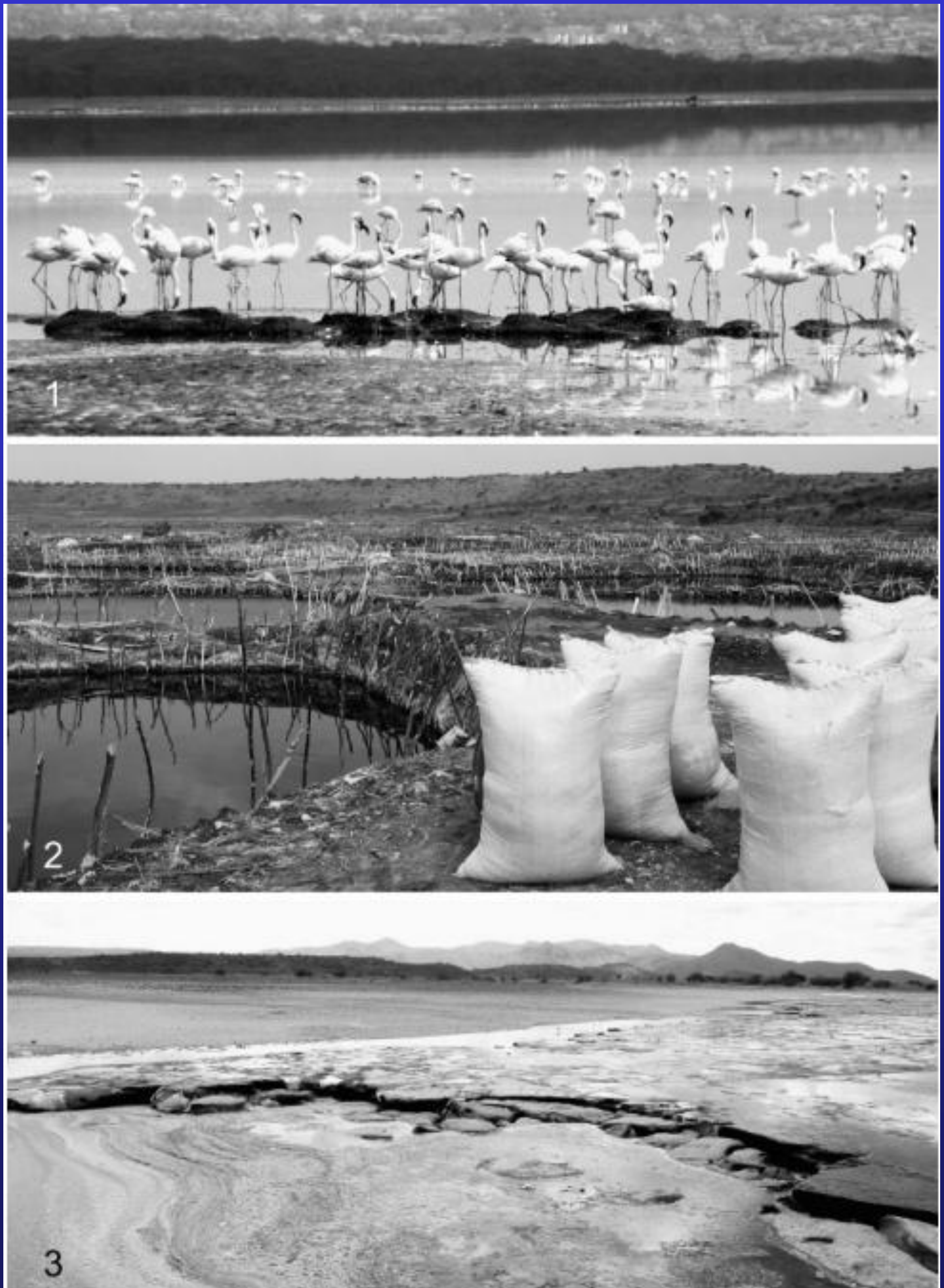
https://doi.org/10.1038/s41467-023-41137-5

Picocystophyceae - *Picocystis salinarum* halophytic



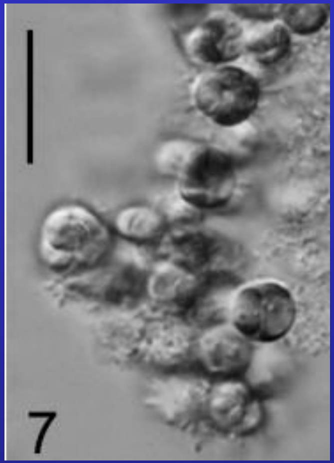
Layered cell wall containing polyarabinose, mannose, galactose and glucose

Mono Lake California



Krienitz et al. 2012

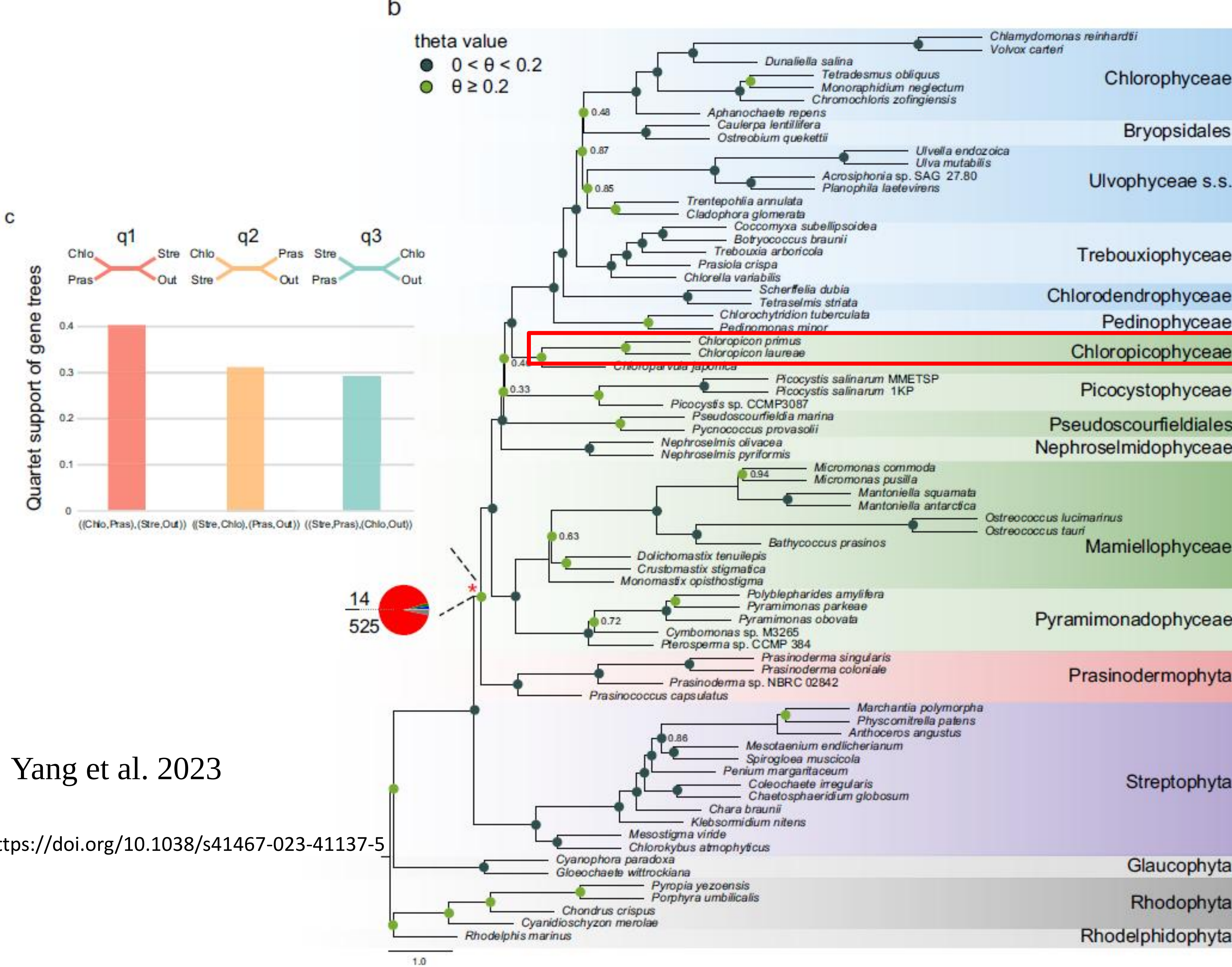
Picocystis salinarum (Chlorophyta) in saline lakes and hot springs of East Africa



Picocystis occasionally replaces the dominant cyanobacterium (*Limnospira fusiformis*), which is the main food resource of Lesser Flamingos, in soda lakes of Bogoria and Nakuru

Východní Afrika – alkalická „soda lakes“

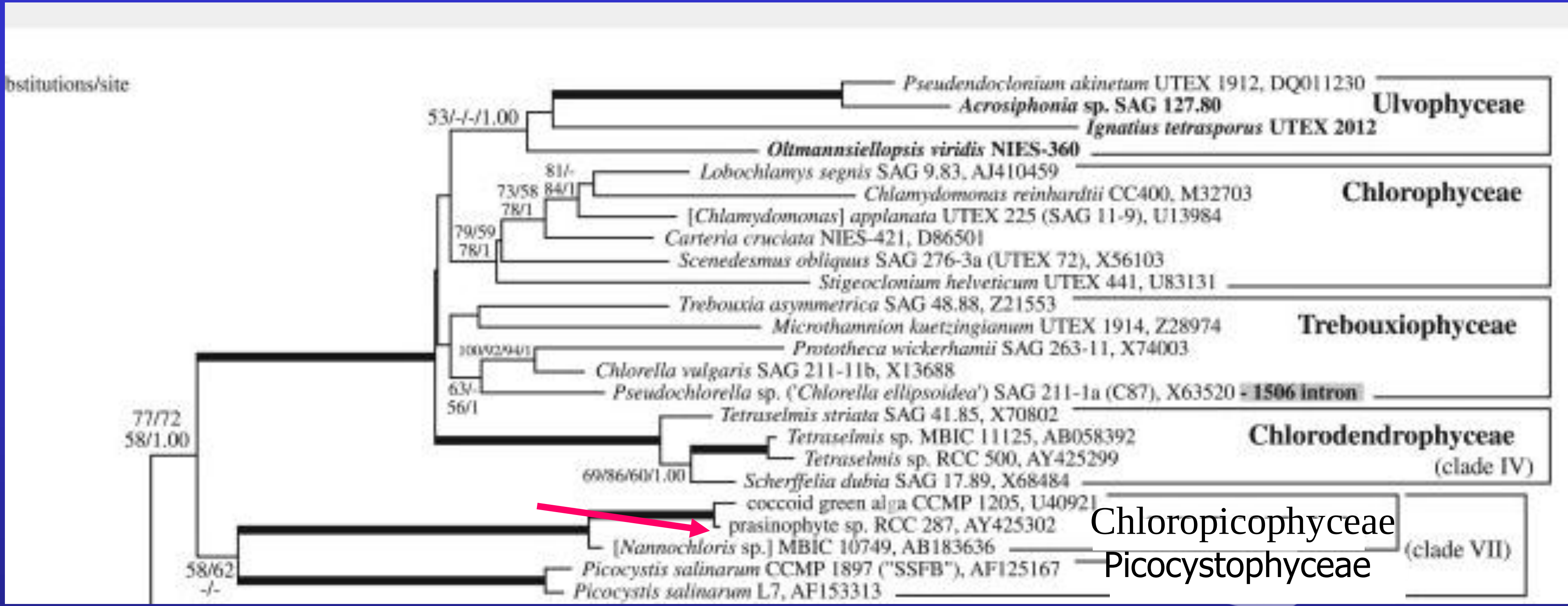
např. jezero Bogoria



Yang et al. 2023

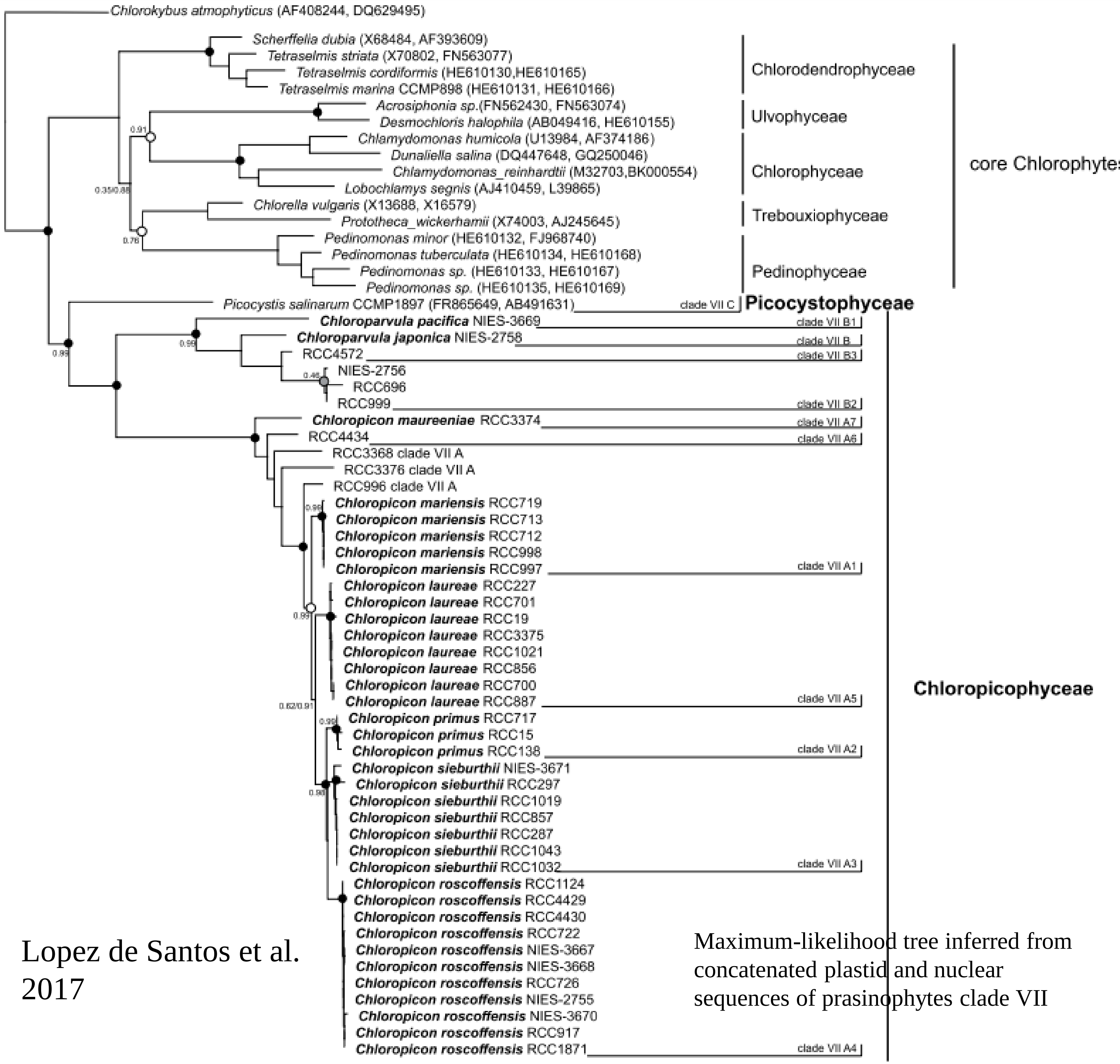
https://doi.org/10.1038/s41467-023-41137-5

Chloropicophyceae



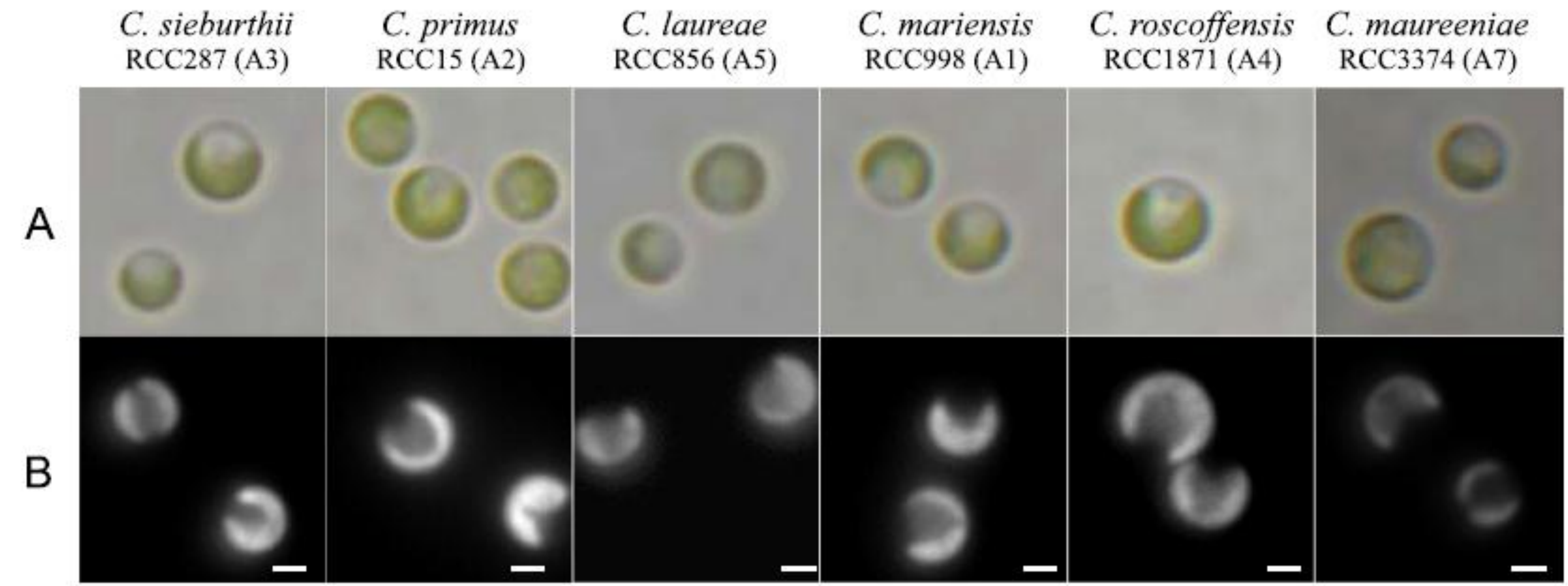
Chloropicon sieburthii

a diameter of 1.5–4 µm, found in oligotrophic marine waters

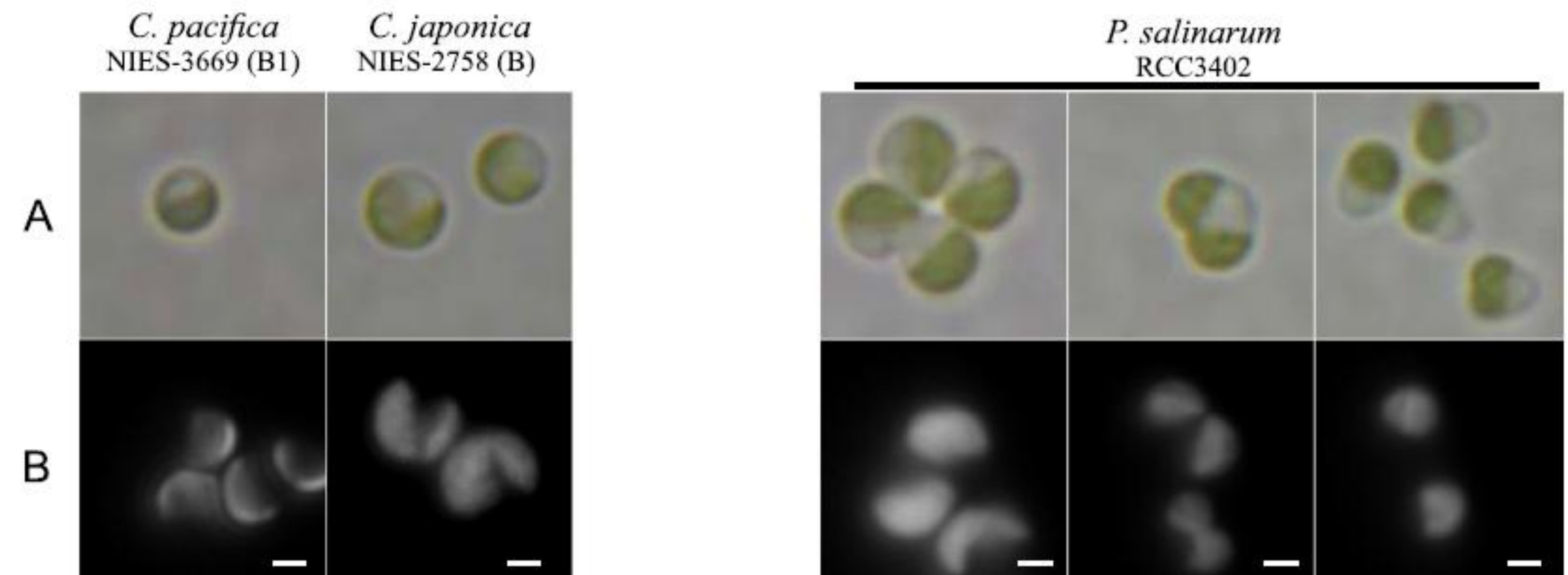


Lopez de Santos et al. 2017

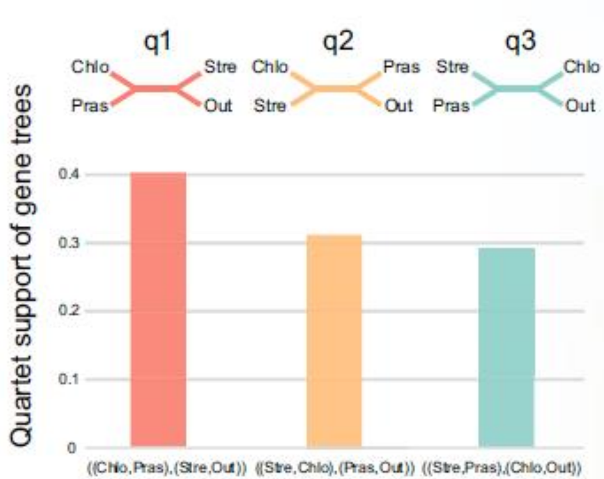
Maximum-likelihood tree inferred from concatenated plastid and nuclear sequences of prasinophytes clade VII

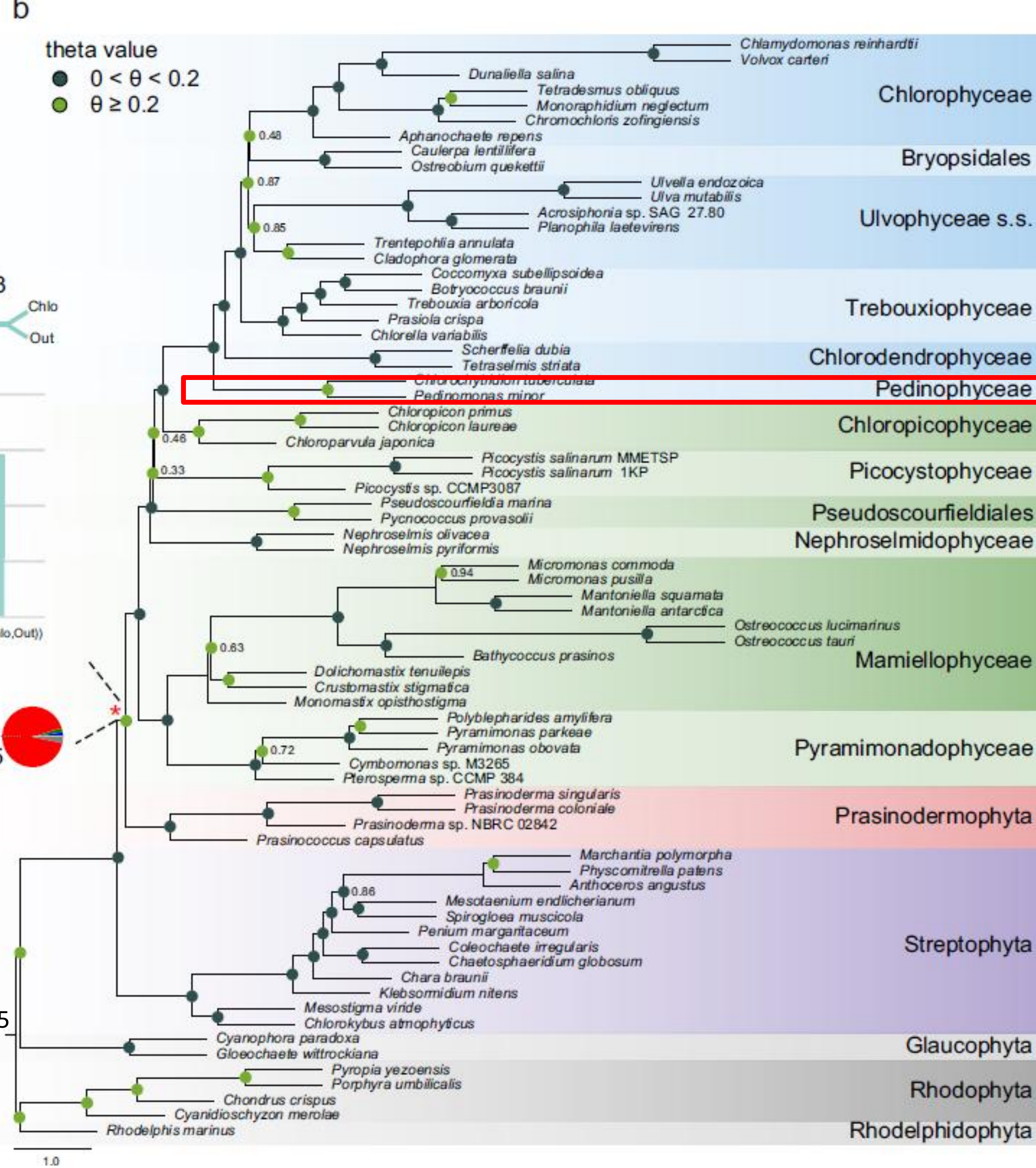


Chloropicon



Core chlorophytes:
Ulvophyceae/Chlorophyceae/Trebouxiophyceae/Chlorodendrophyceae/
Pedinophyceae





Yang et al. 2023

https://doi.org/10.1038/s41467-023-41137-5

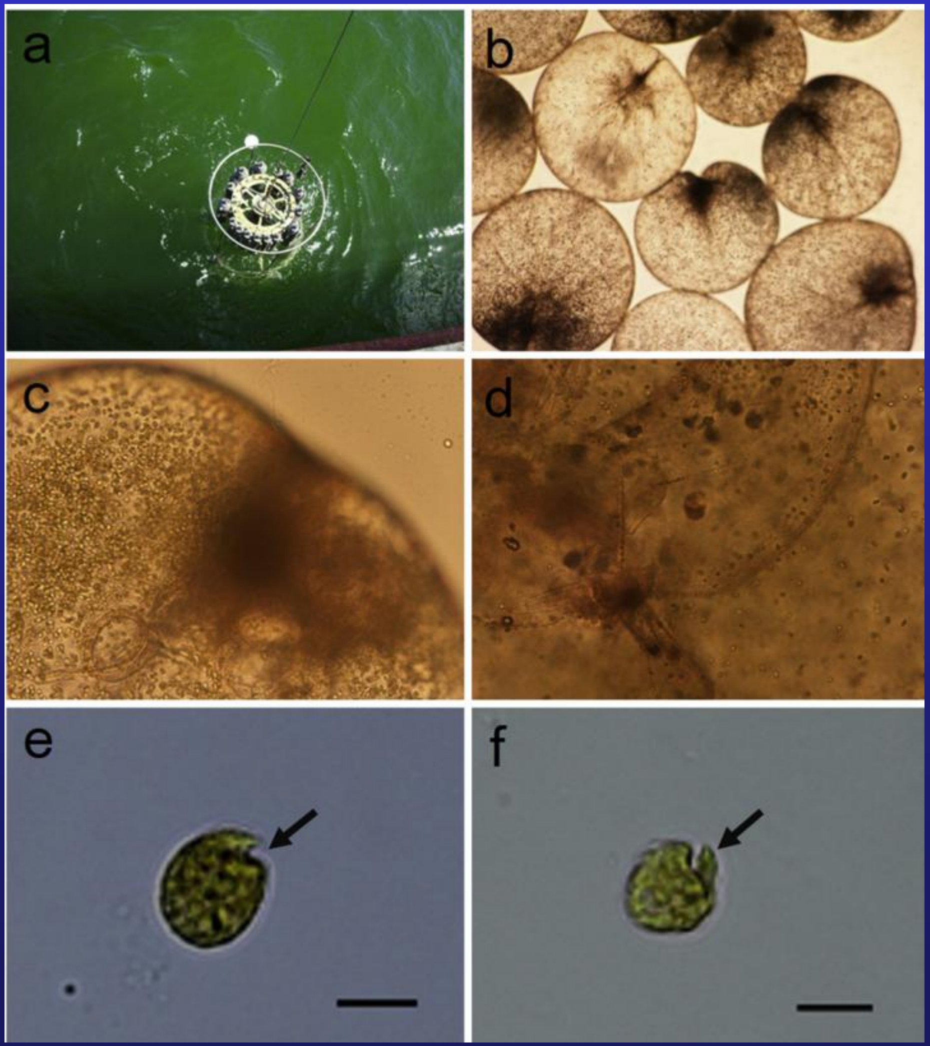
Pedinophyceae

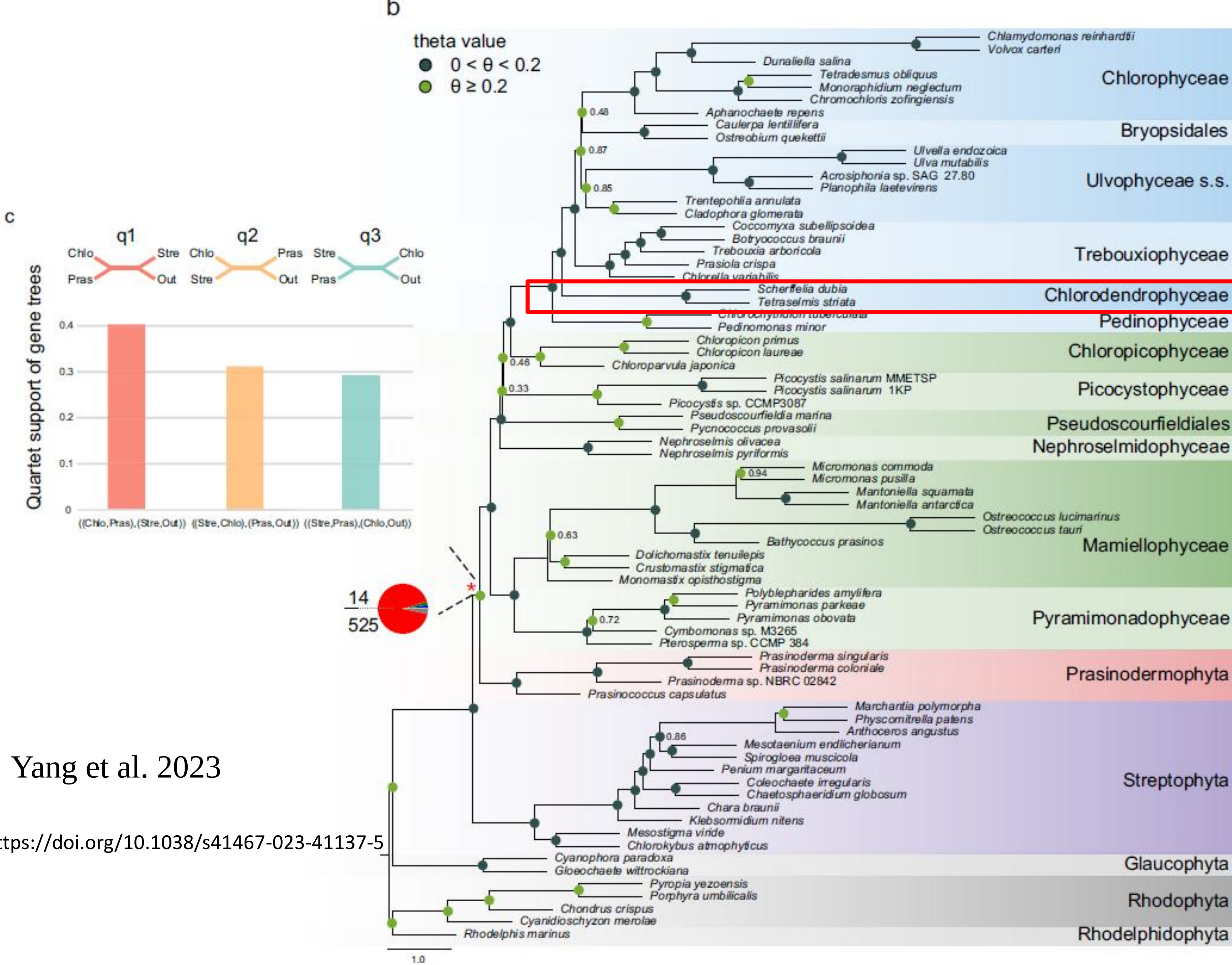
Marsupiomonadales – live in seas, in salt or brackish waters, and are part of plankton. The second lineage – Pedinomonadales – is characterized by freshwater species or species living in soil

2.5 - 10 µm

green *Noctiluca* contains a large number of endosymbiotic algal cells – blooms in the northern Arabian Sea

Pedinomonas noctilucae

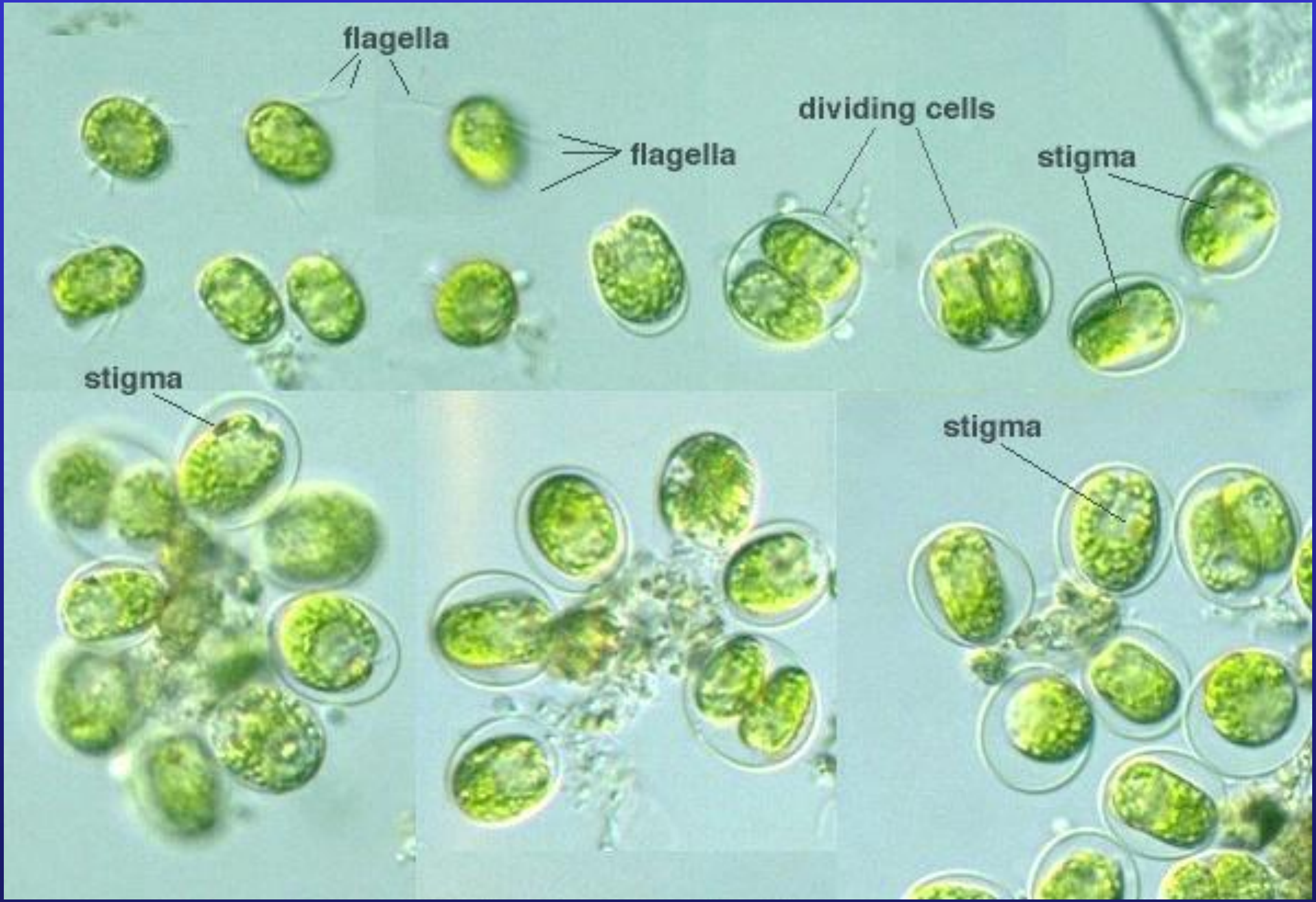




Yang et al. 2023

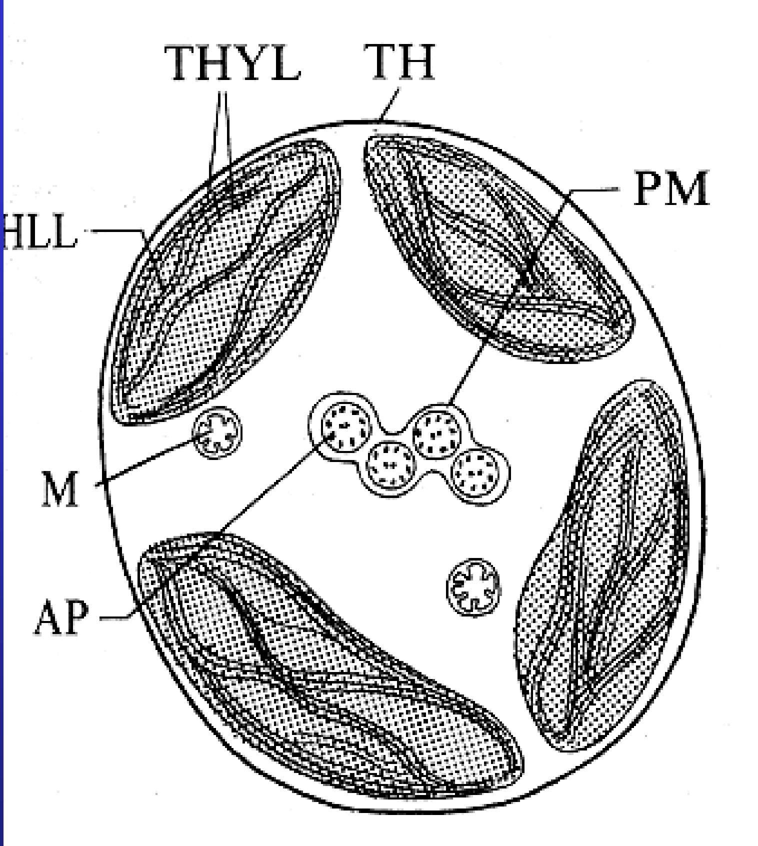
https://doi.org/10.1038/s41467-023-41137-5

Chlorodendrophyceae

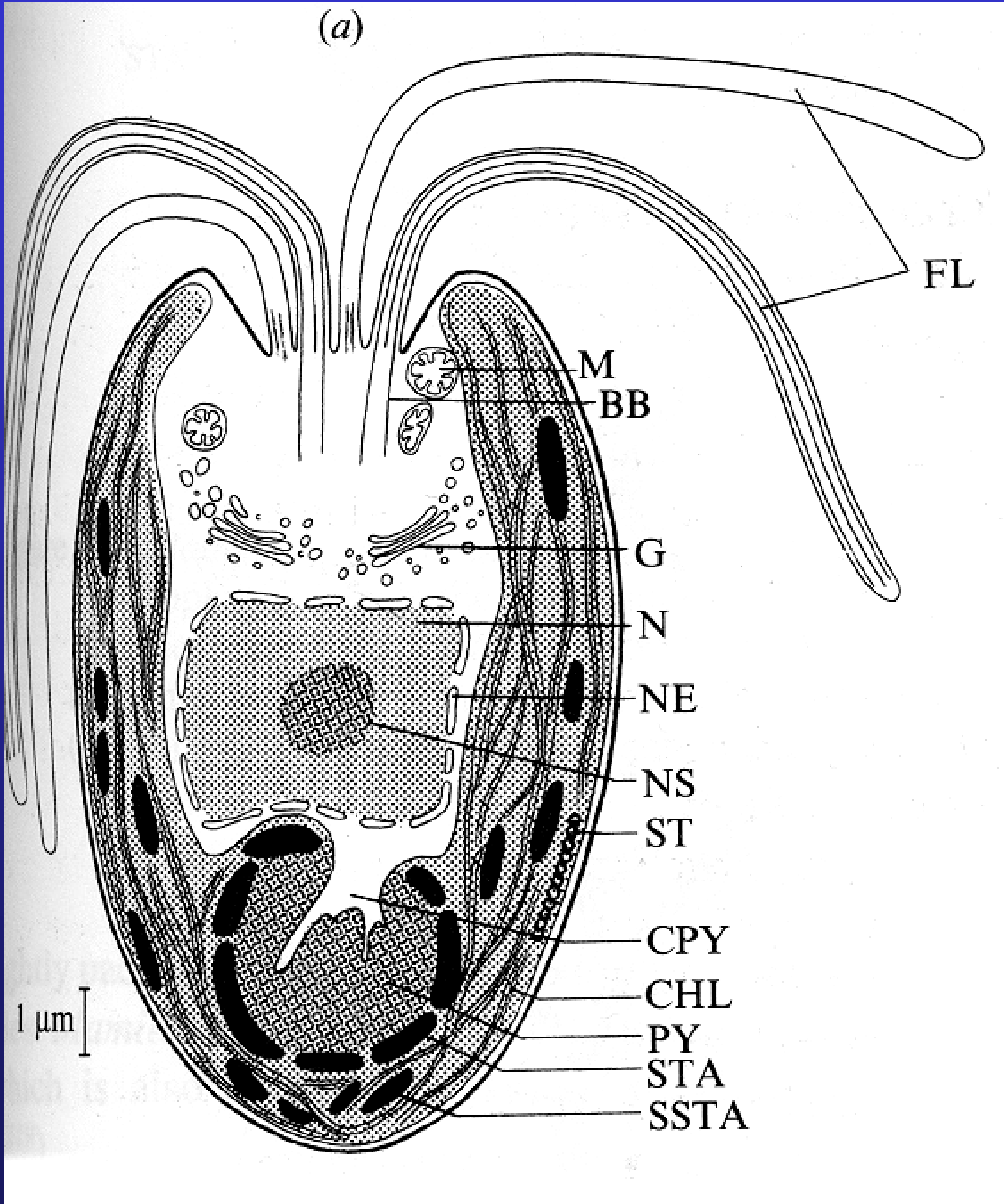


Tetraselmis

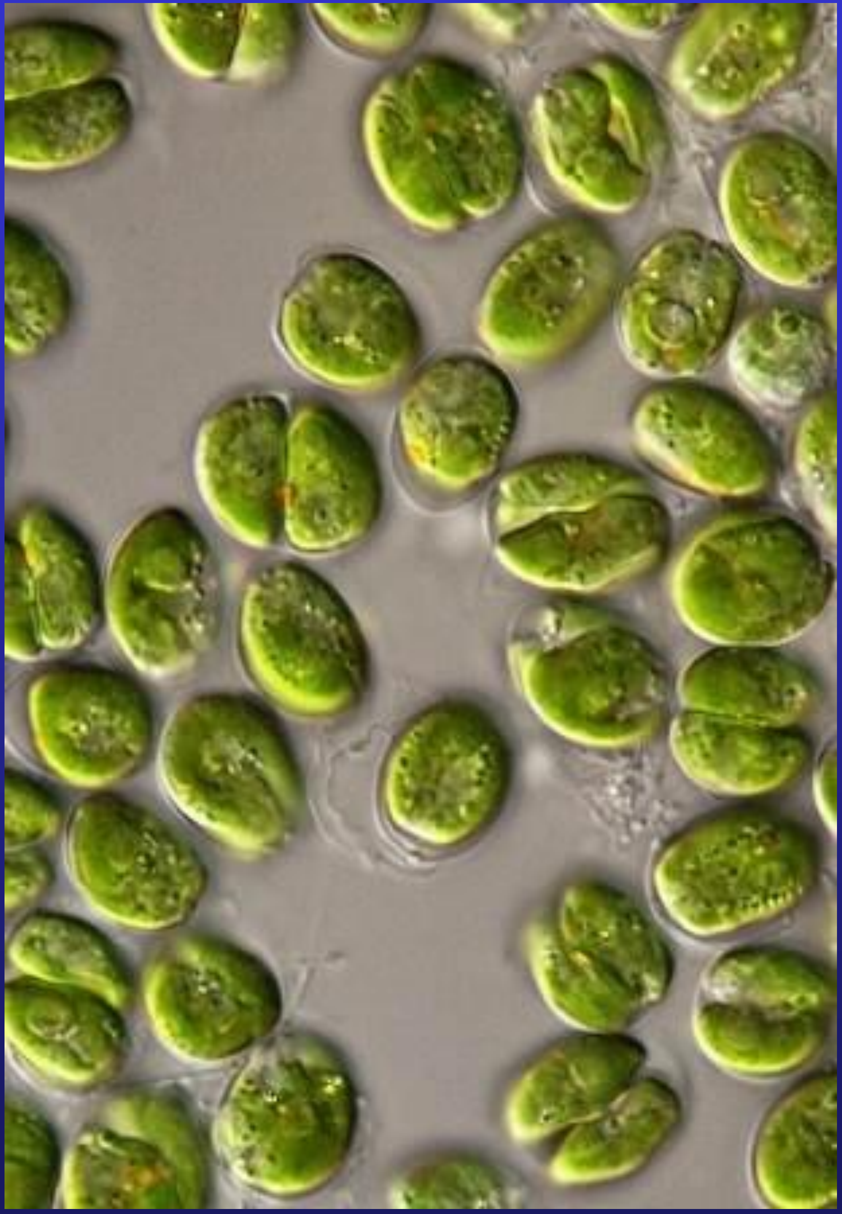
Chlorodendrophyceae



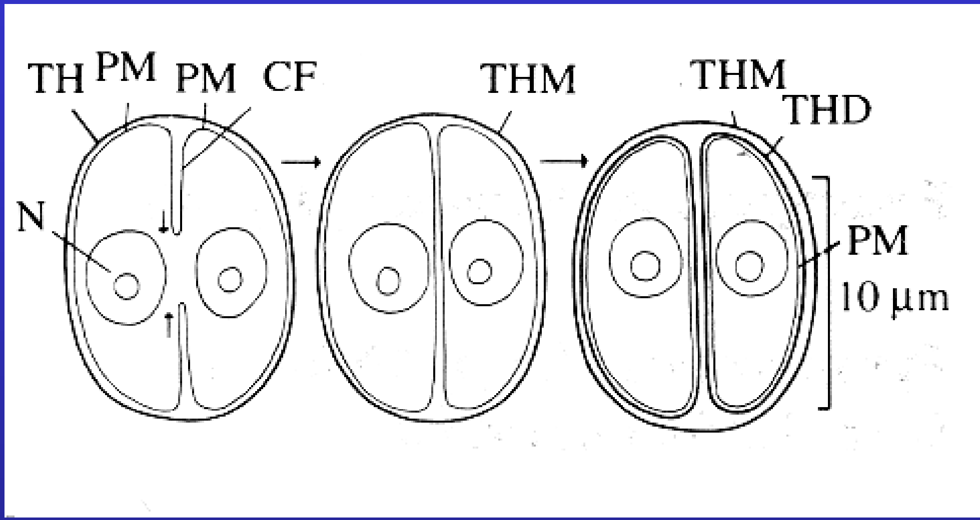
Tetraselmis suecica



Mitóza a cytokineze



- na povrchu kryté thékou

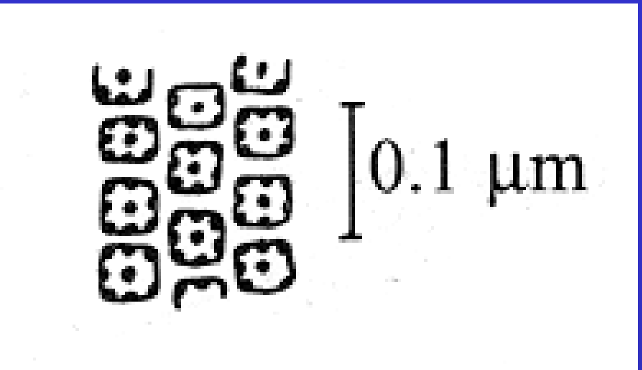


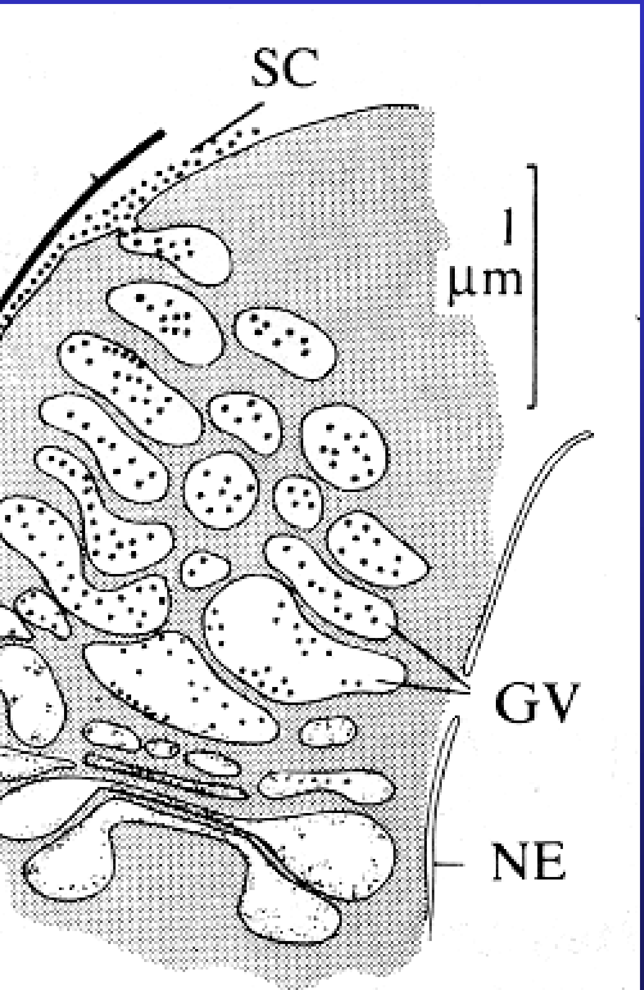
Tetraselmis suecica

shed flagella - division within the mother theca

Scales fuse to form organic theca

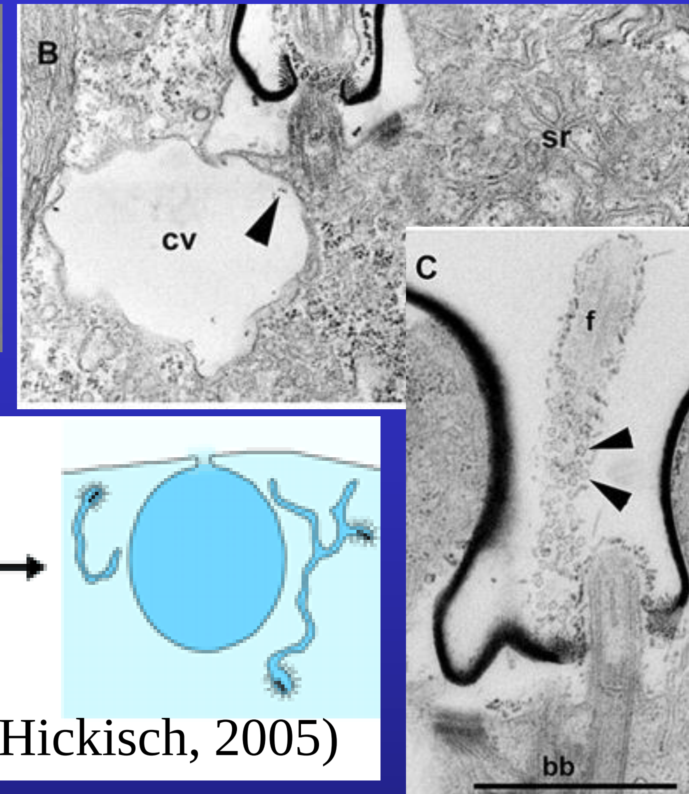
Chlorodendophyceae

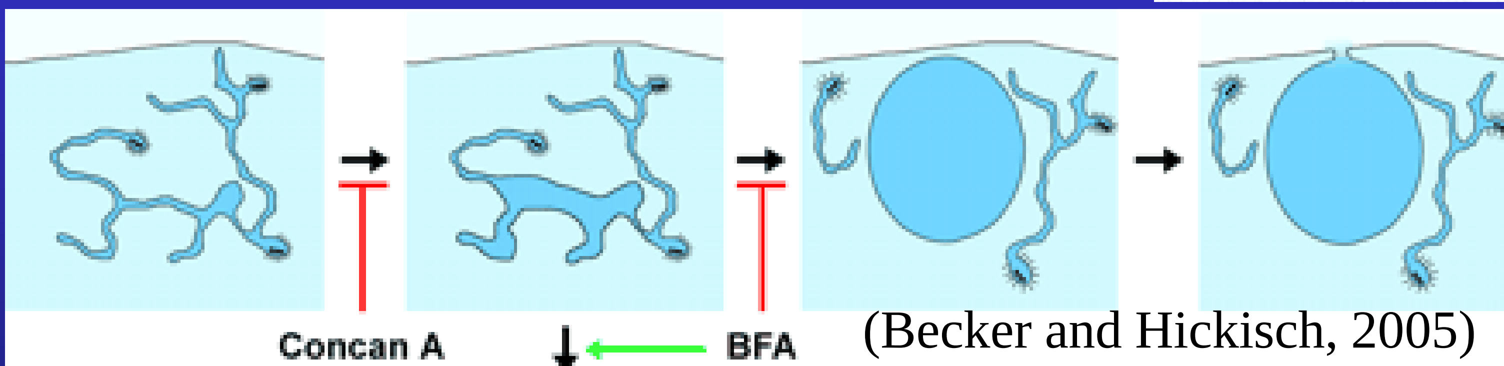




Tetraselmis

Contractile vacuoles



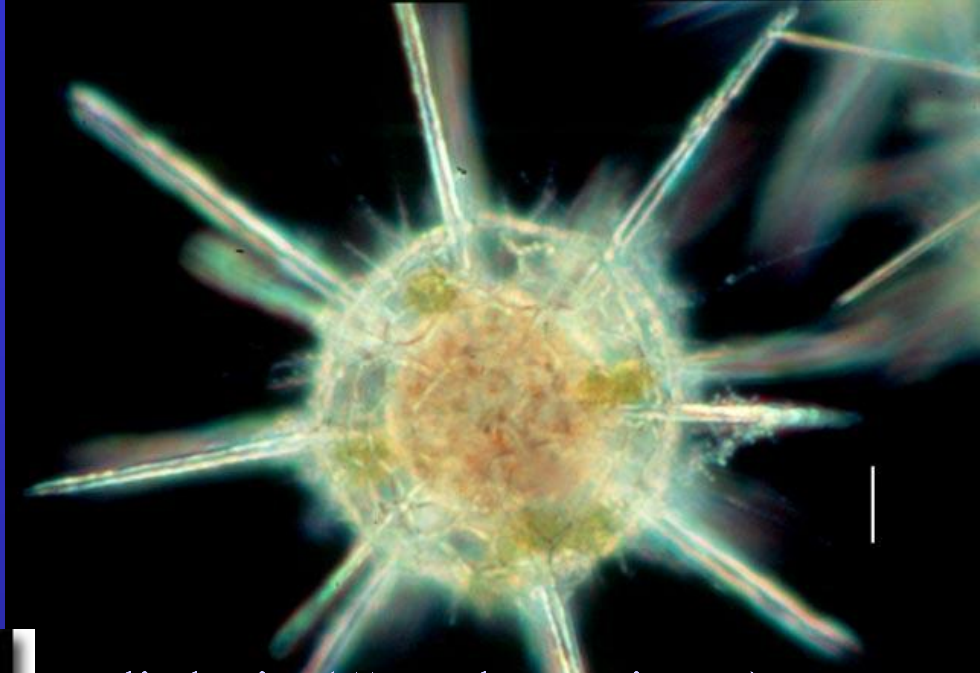


(Becker and Hickisch, 2005)

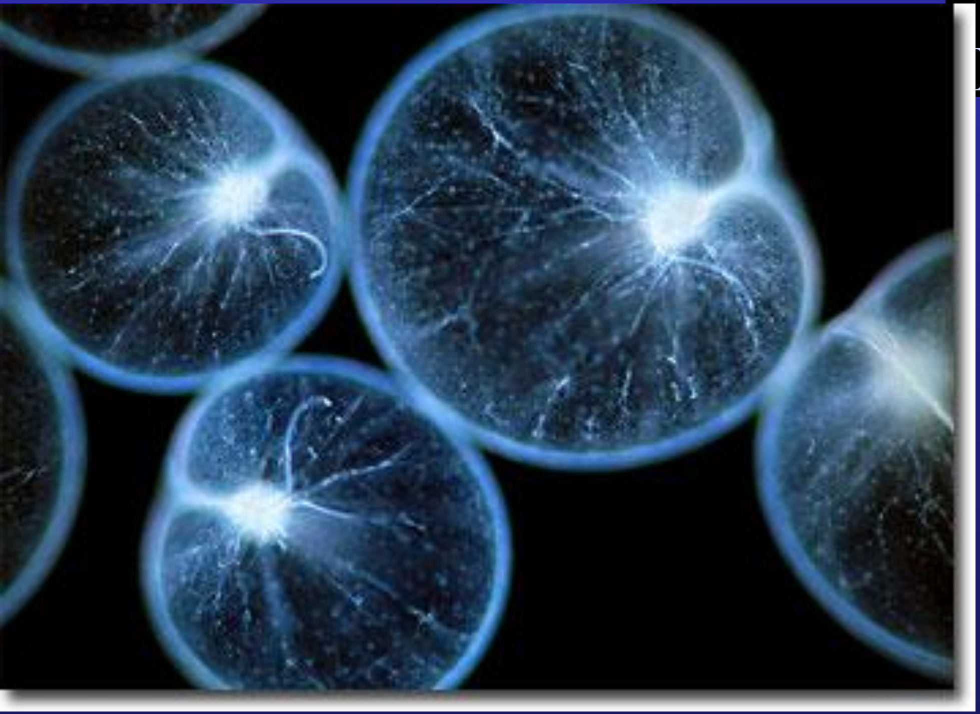
CV – *Scherffelia* - Osmoregulatory organelle – regularly removes water from the cell. Brefeldin – inhibits secretion, Golgi apparatus function, and the function of contractile vacuoles (blocks the fusion of the CV membrane with the plasma membrane). After Brefeldin application, a large central vacuole forms (representing the diastole phase) – the process is reversible; if the cell is placed in a hypertonic medium, the CV shrinks. An experimental model for studying diastole, essentially slowing down the entire process (otherwise 20ms)

Ekology

symbionts of different heterotrophic organisms



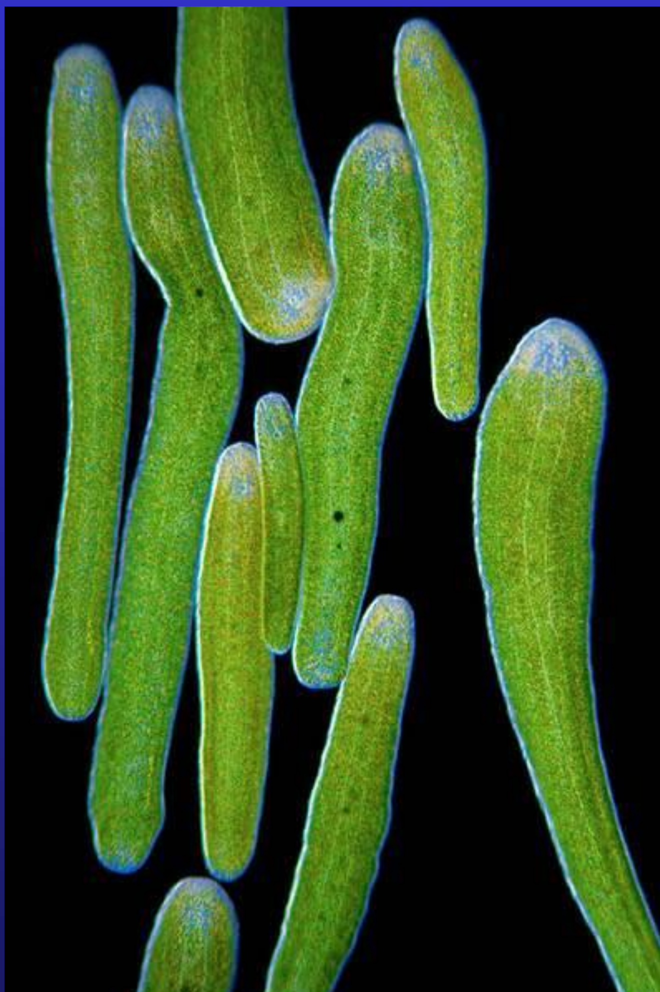
Radiolaria (tř. Polycystinea)

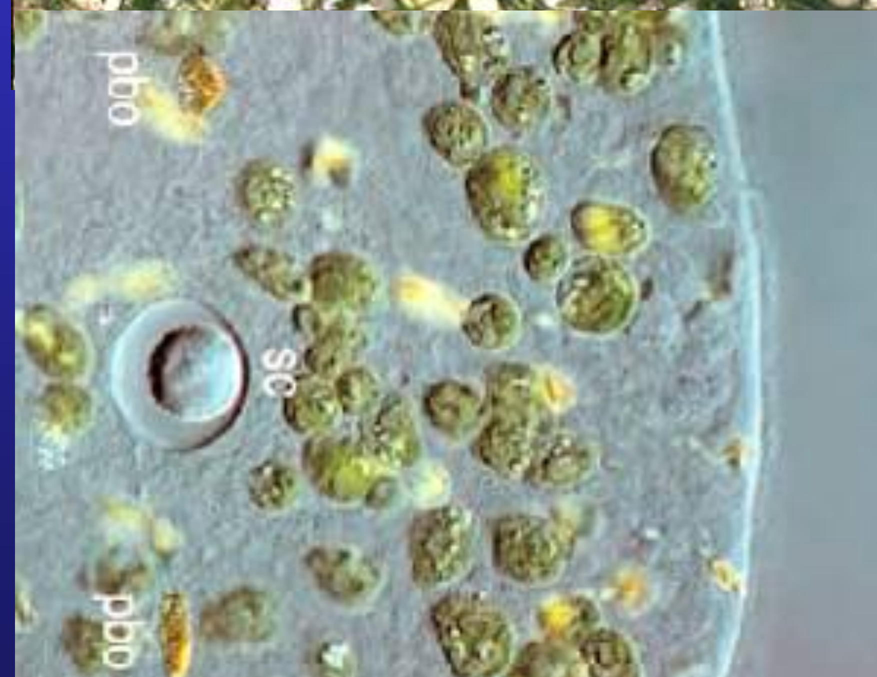


Noctiluca

Ekology

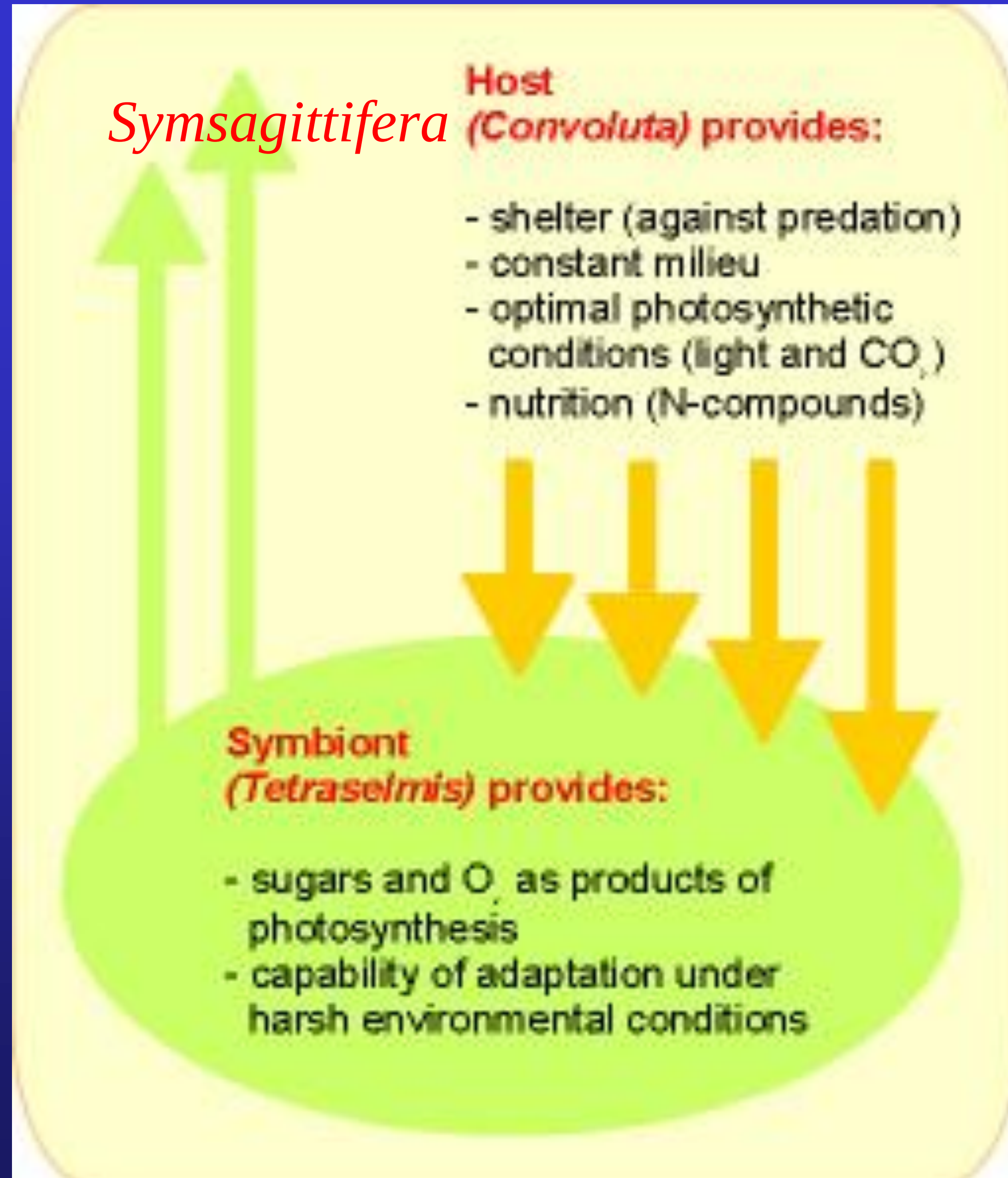
symbionts of different heterotrophic organisms





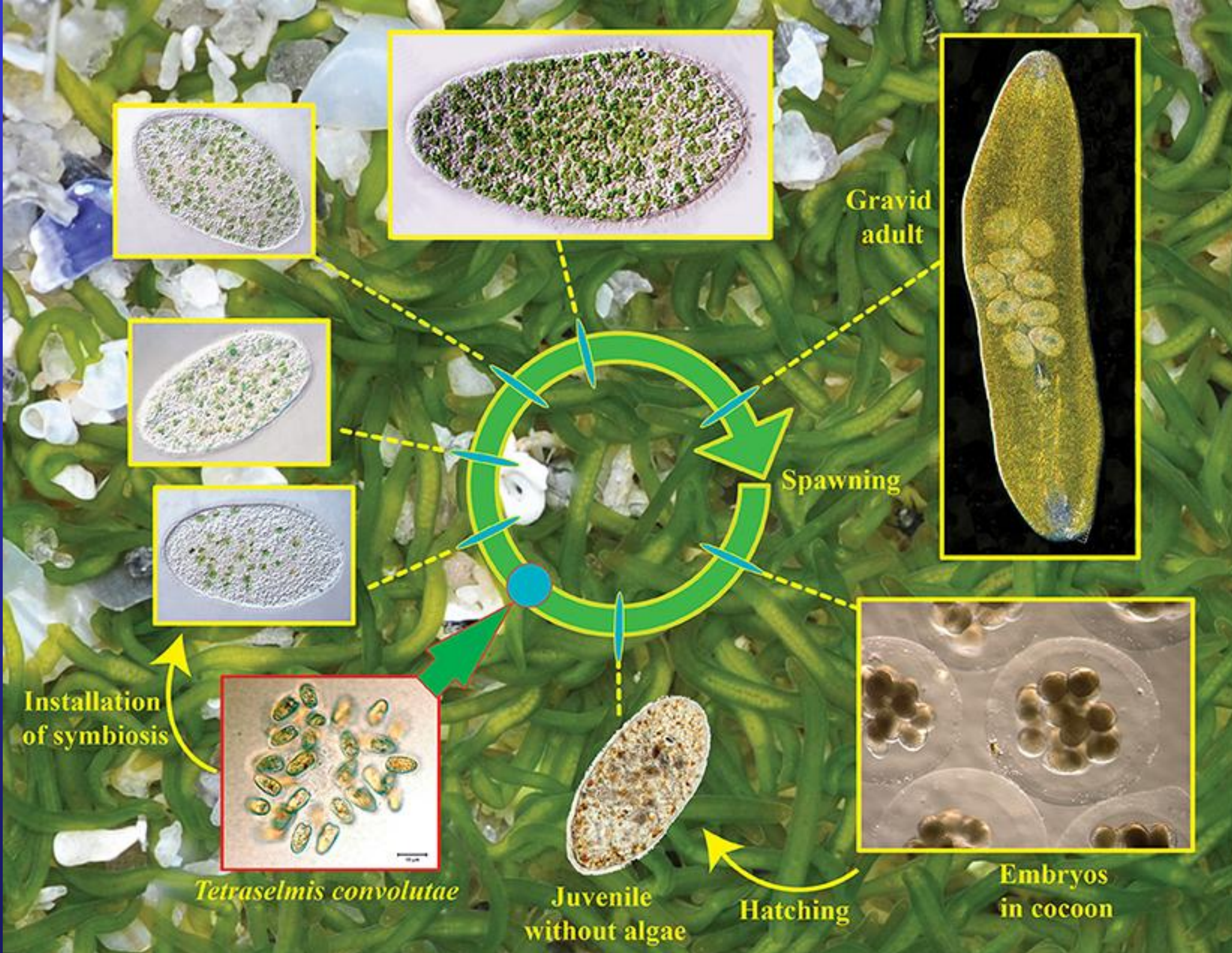
(Convoluta) Symsagittifera roscoffensis - flatworms Acoela– no mouth


Channel
Islands


Symsagittifera
Host
(Convoluta) provides:
- shelter (against predation)
- constant milieu
- optimal photosynthetic conditions (light and CO_2)
- nutrition (N-compounds)
Symbiont
(Tetraselmis) provides:
- sugars and O_2 as products of photosynthesis
- capability of adaptation under harsh environmental conditions

Akvitaine - France

Atlantic ocean shore

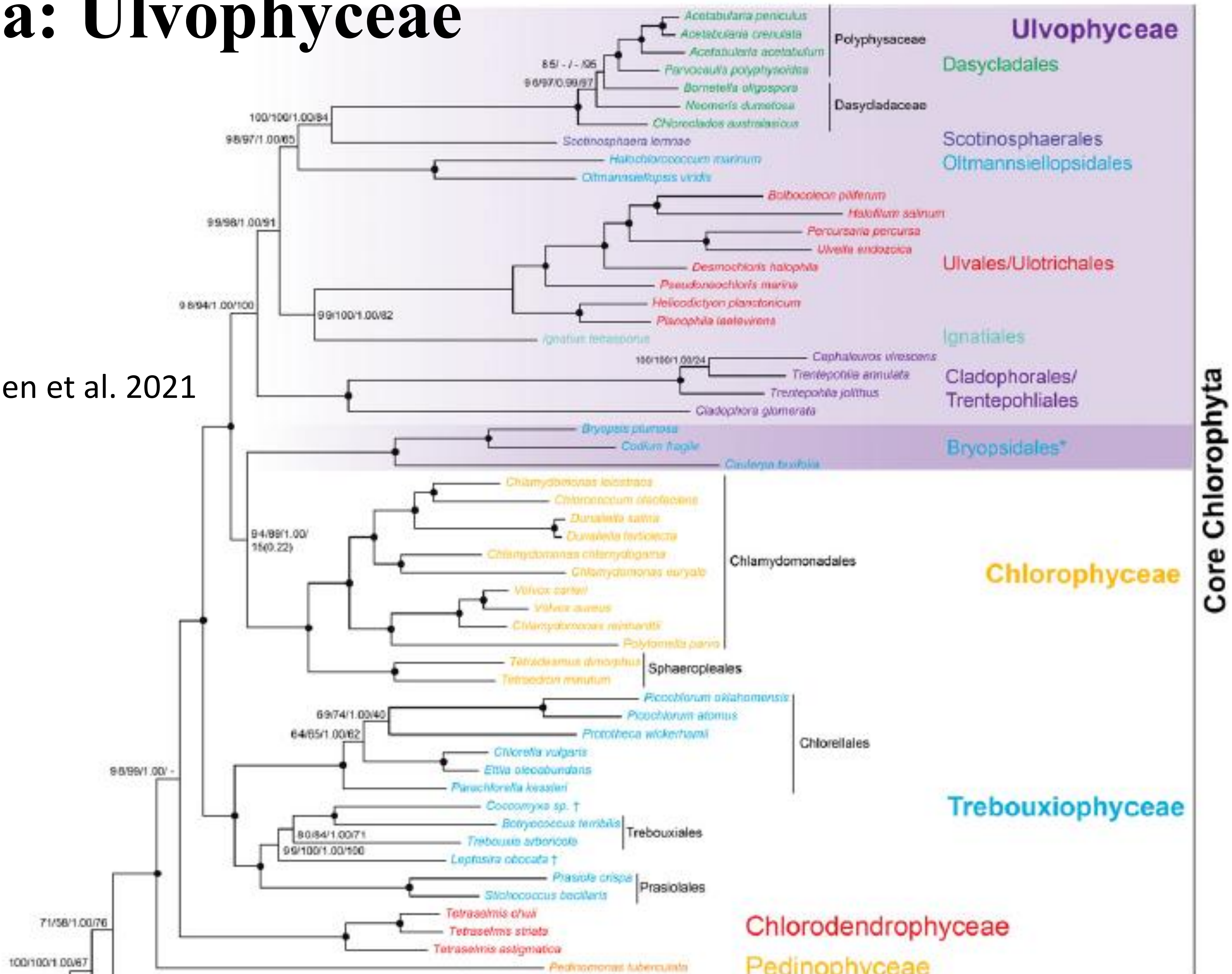

Gravid
adult
Spawning
Installation
of symbiosis
Tetraselmis convolutae
Juvenile
without algae
Hatching
Embryos
in cocoon

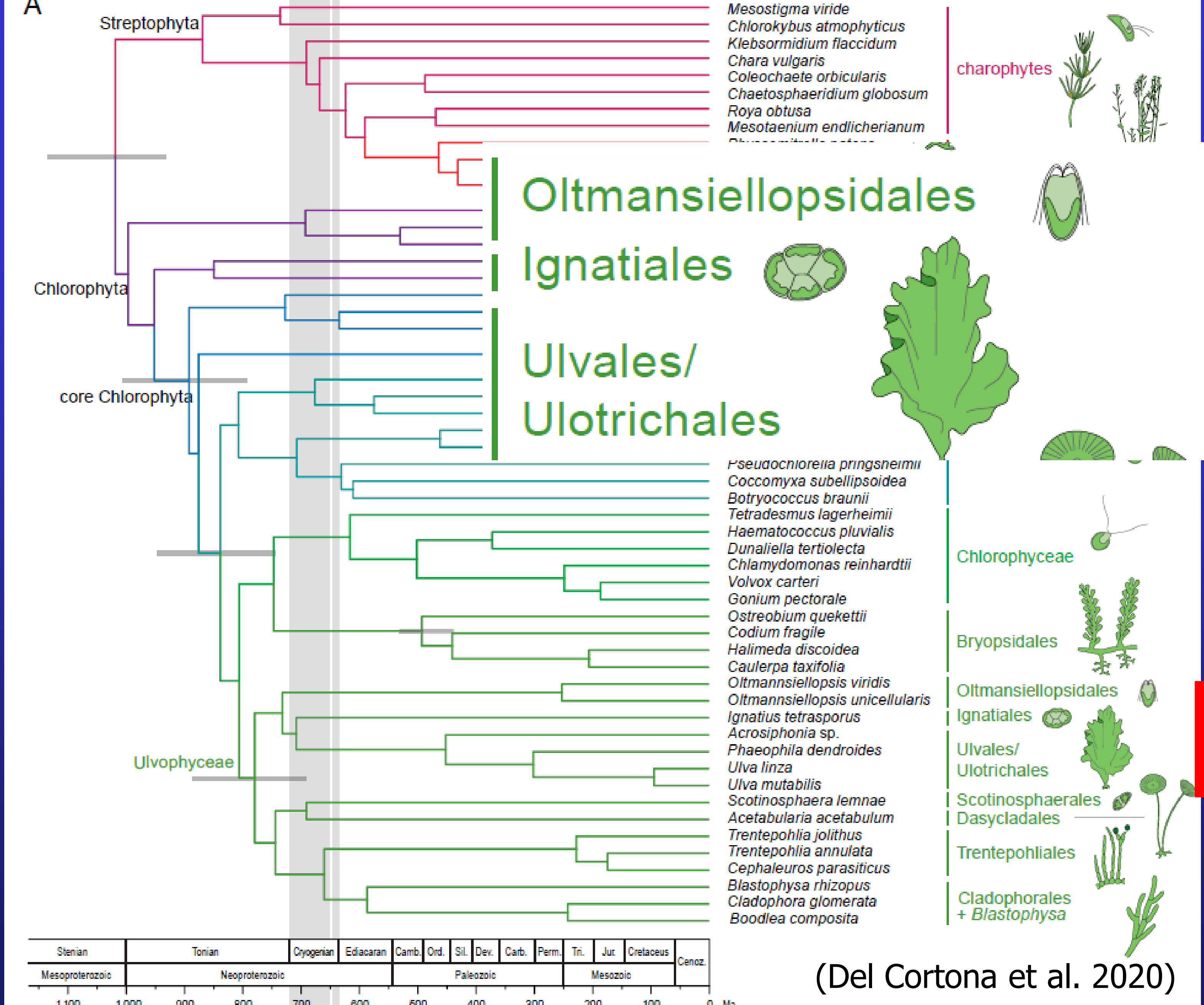
polyunsaturated
fatty acids

Live Foods for **Feeding** Aquarium Fish, Inverts & **Corals**

Třída: Ulvophyceae

Gulbrandsen et al. 2021



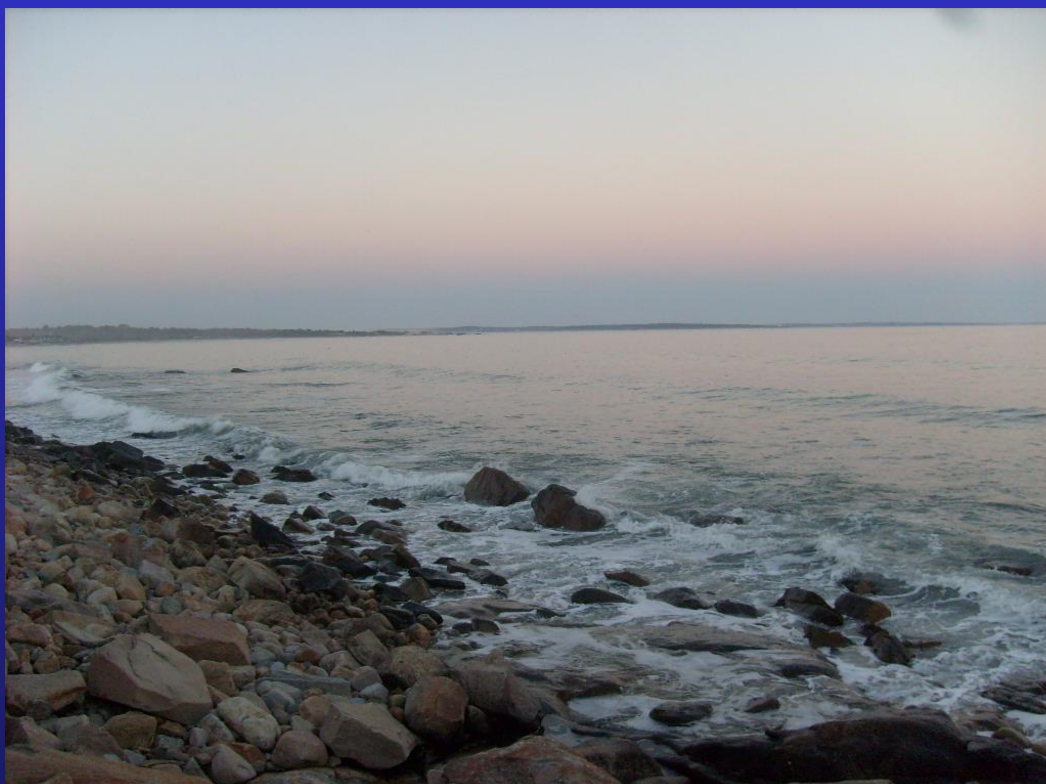


(Del Cortona et al. 2020)

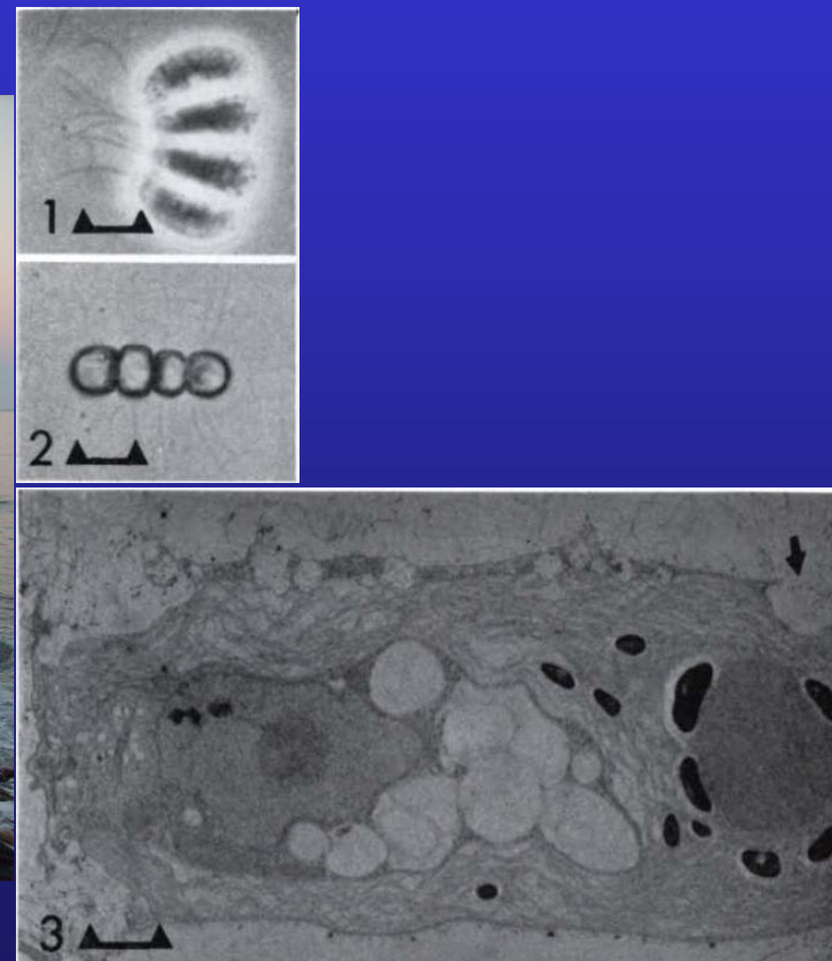
Time-calibrated phylogeny of the green algae. (A) The topology of the tree is based on the ML analysis inferred from a concatenated amino acid alignment of 539 nuclear genes

Oltmansiellopsidales

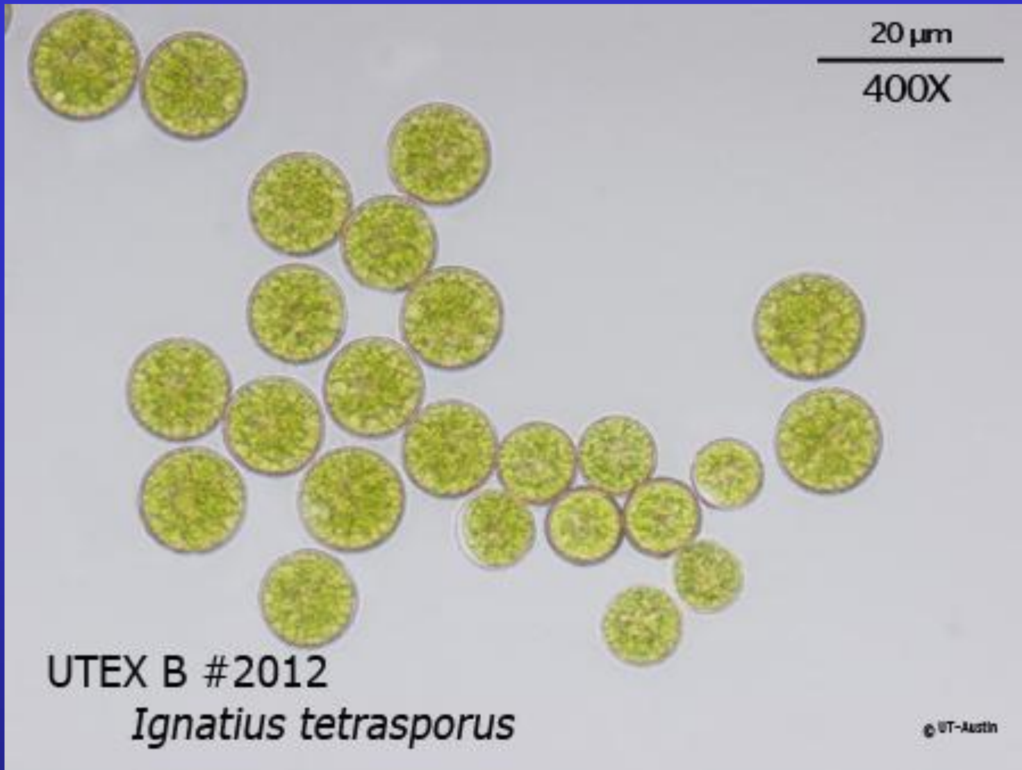
Oltmansiellopsis viridis -a quadriflagellate green alga is described from temperate coastal waters. It occurs primarily as four-celled colonies,

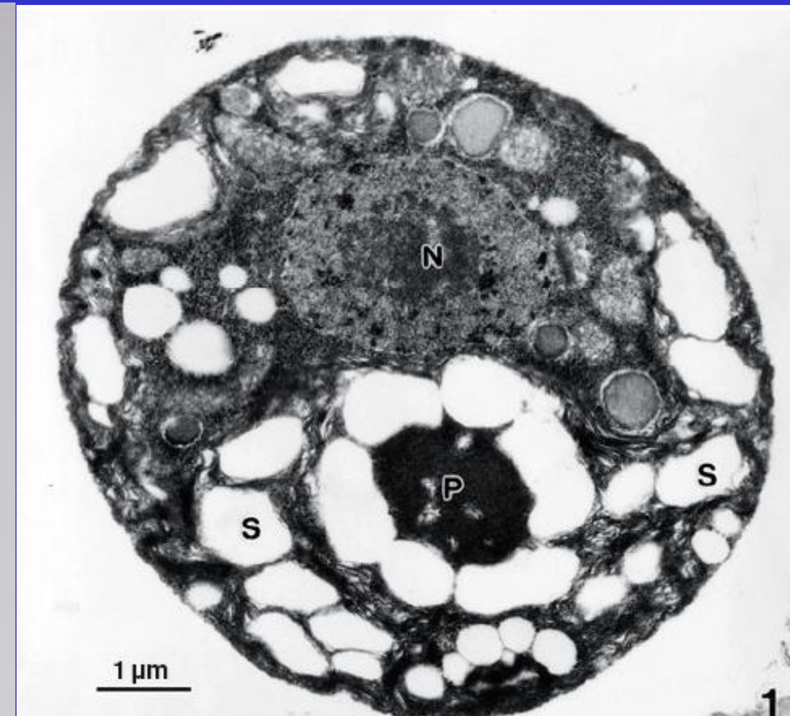


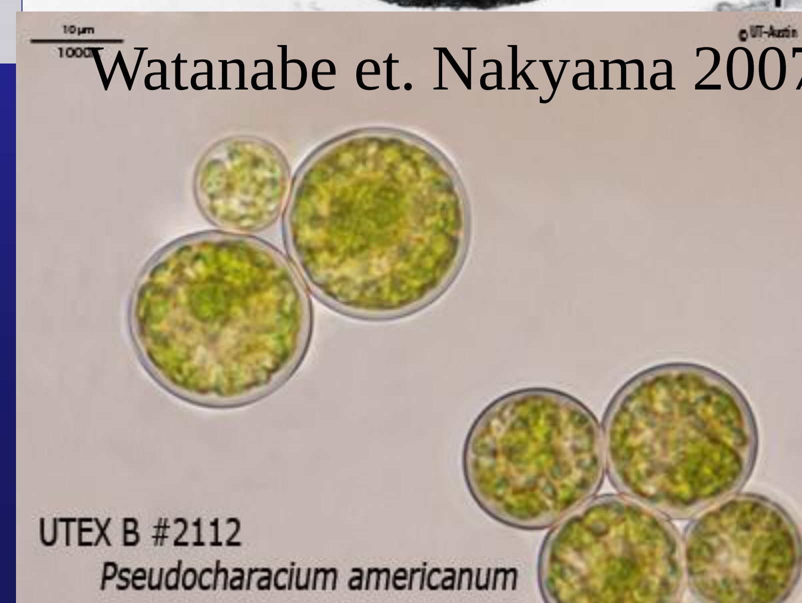
Narragansett Bay, Rhode Island, USA



Ignatiales







Watanabe et. Nakyama 2007

Coccoids from damp terrestrial habitats

A young vegetative cell included a single nucleus and a cup-shaped chloroplast that contained
a pyrenoid and stroma starch grains

Ulvales/Ulotrichales

Basic Characteristics:

•Thallus can be coccoid, filamentous, siphonous, or parenchymatous.

•Zoids have 2 or 4 flagella (with a cruciate arrangement of flagellar roots and CCW orientation of basal bodies); some representatives of Ulotrichales have rhomboid scales covering the surface of zoids.

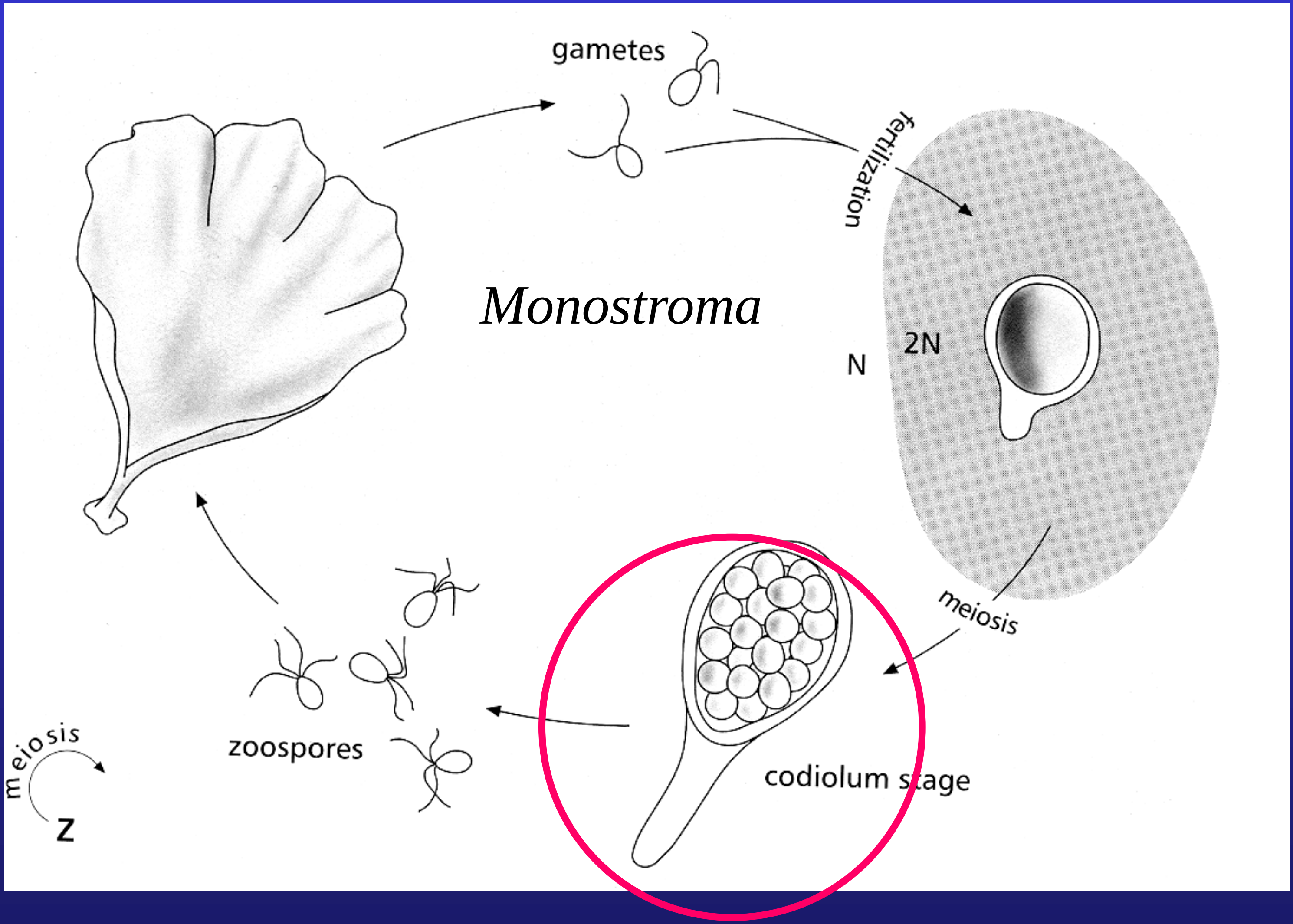
•Mitosis is closed, with a persistent telophase spindle (lacking phycoplast and fragmoplast).

•Each cell contains a parietal chloroplast (band-shaped or cup-shaped), sometimes perforated, with one or several pyrenoids.

•Haplontic or diplo-haplontic life cycle, with the formation of thick-walled hypnozygotes.

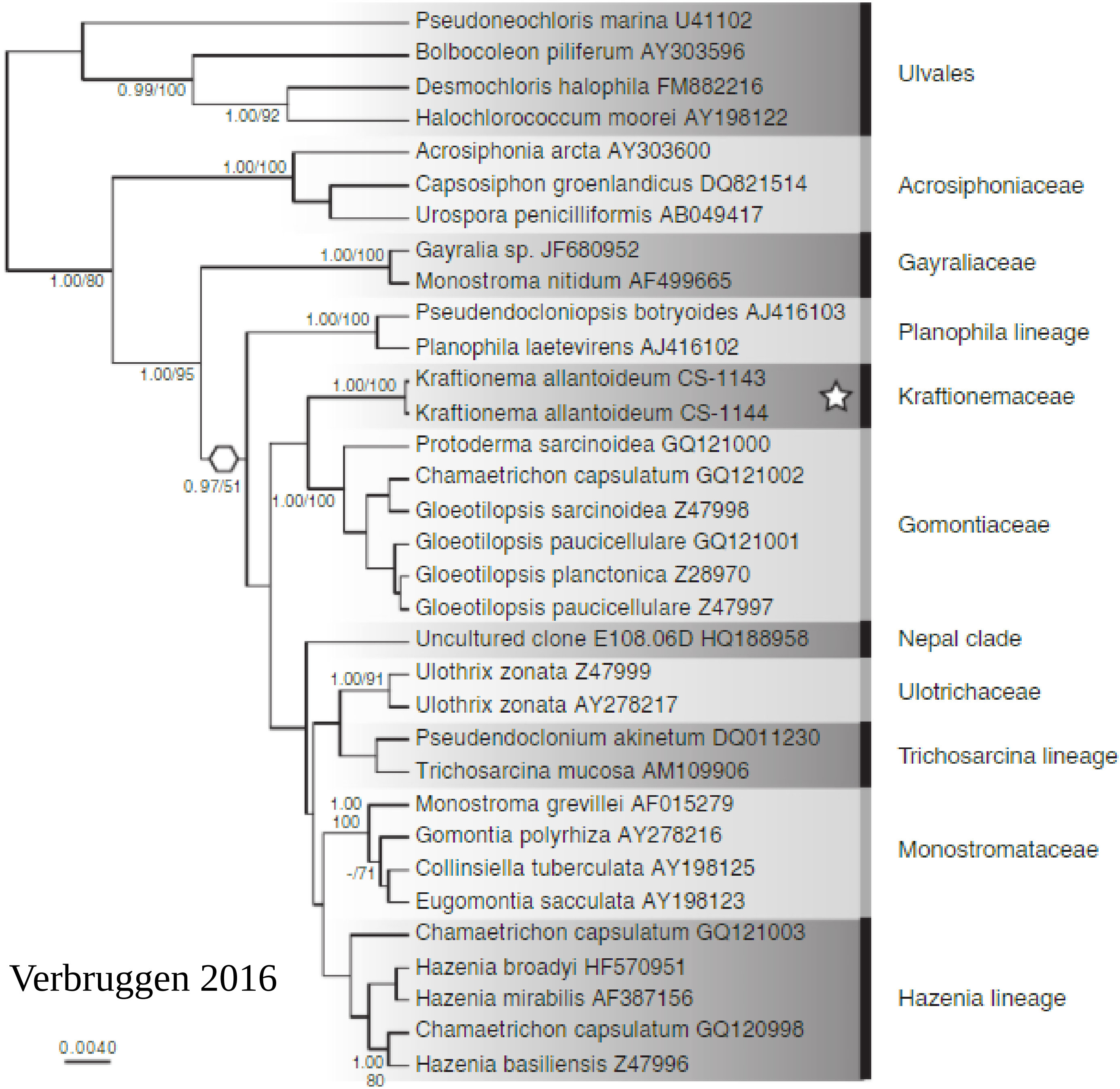
•Representatives of this class are almost exclusively marine organisms.

Řád: Ulotrichales (Codiolales)



•*Codiolum* stages can develop inside mussels or endophytically within the thalli of macroalgae encrusted with limestone, providing a protected and stable microclimate.
•Under favorable conditions, they germinate into four-flagellated zoospores (meiospores).

Phylogenetic tree of Ulotrichales inferred from 18S ribosomal RNA sequences



Wetherbee et Verbruggen 2016

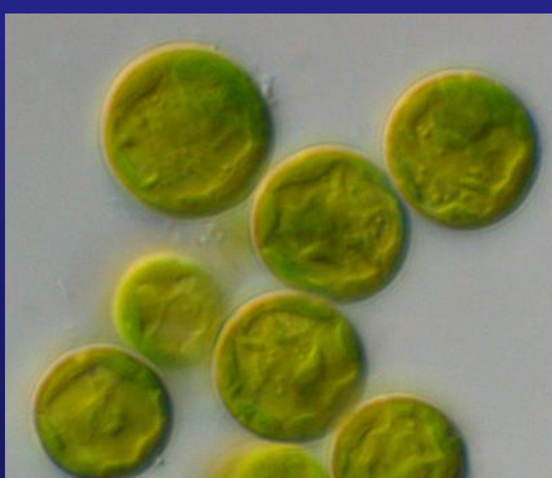
Chlorocystis

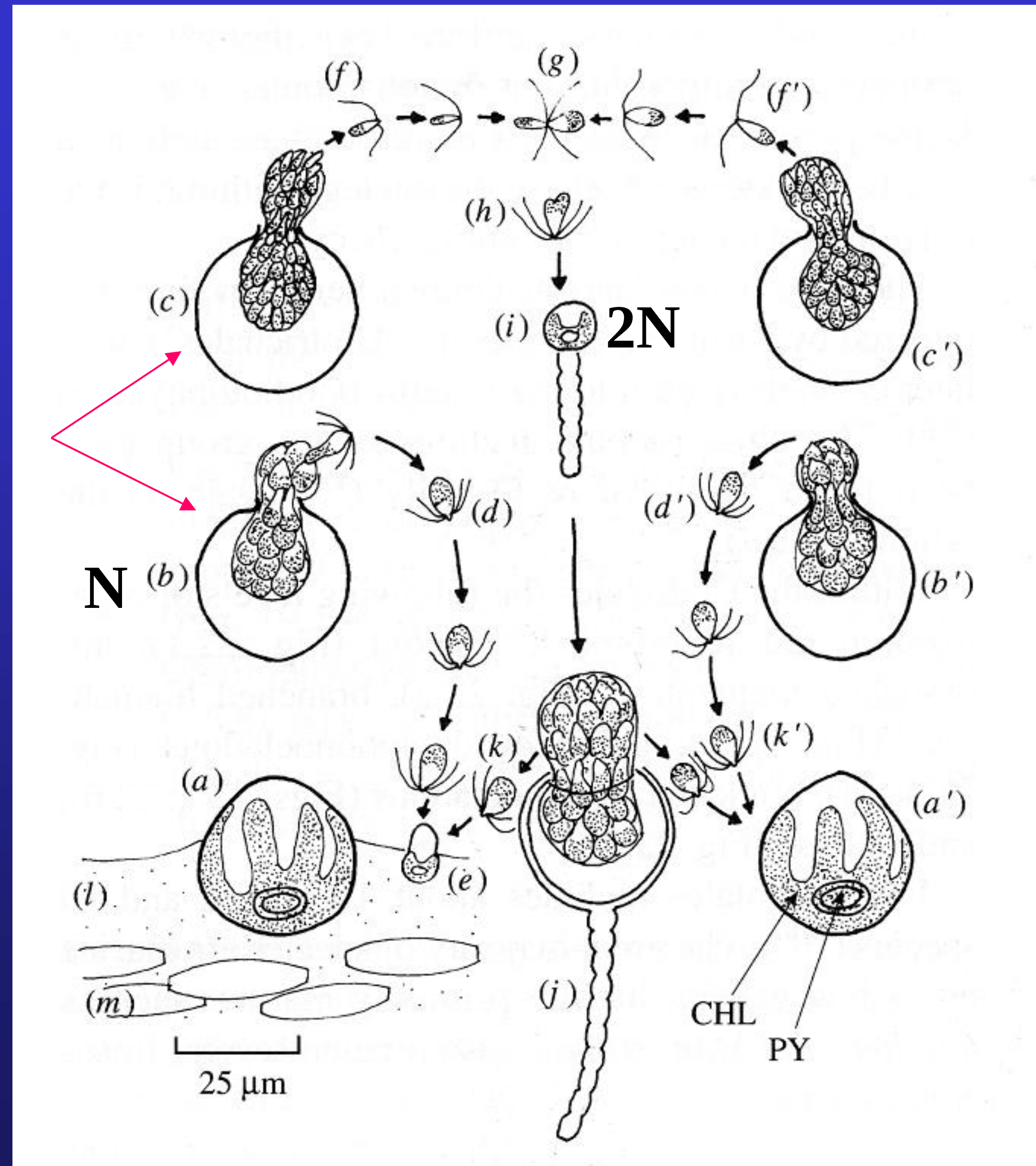
endophyte, haplontic life cycle, codiolus stage

anizogamy

heterothalism

evolutionary parallelism (*Trebouxia*, *Chlorococcum*)

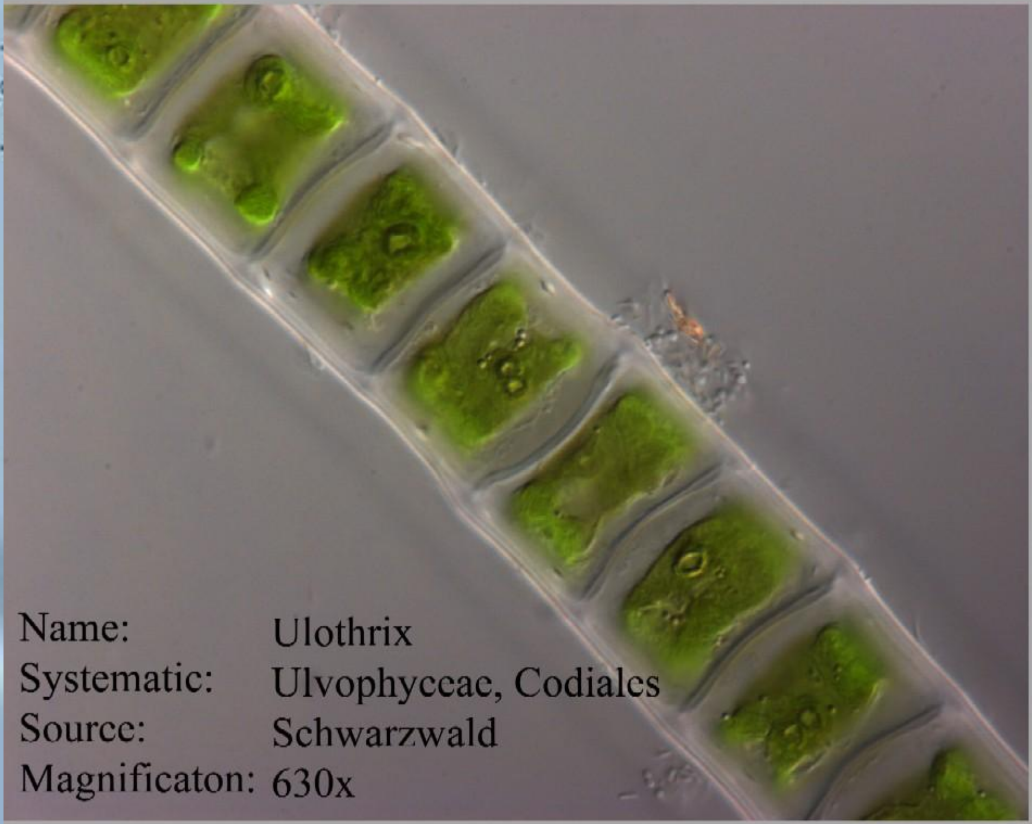


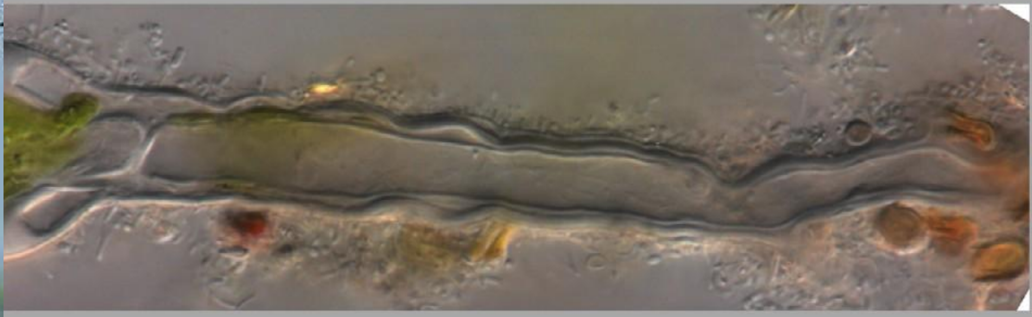


Ulothrix

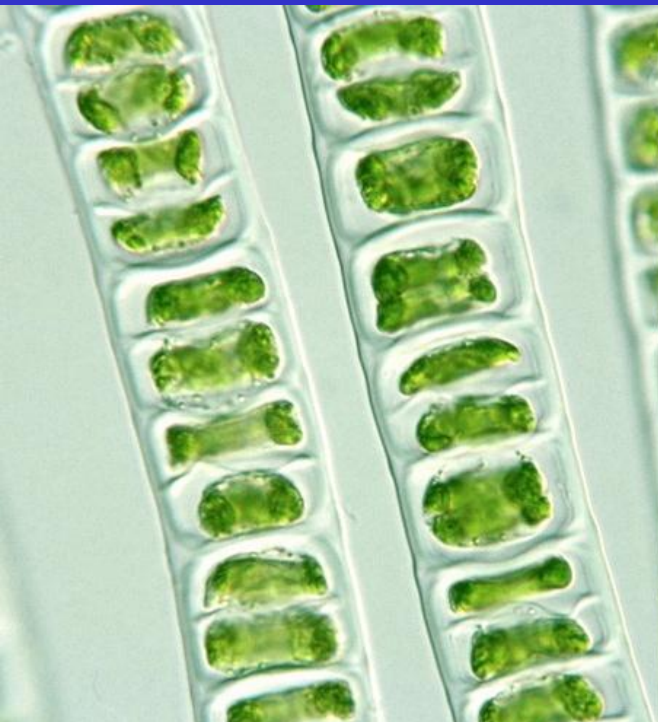

SINICE & ŘASY.cz

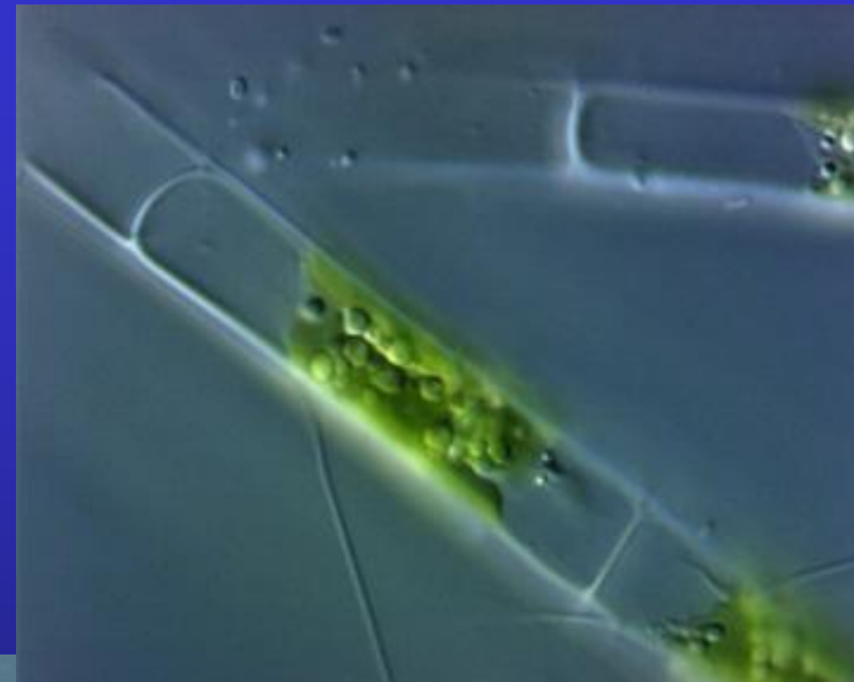

50 µm


Name: Ulothrix
Systematic: Ulvophyceae, Codiales
Source: Schwarzwald
Magnificaton: 630x



Ulothrix



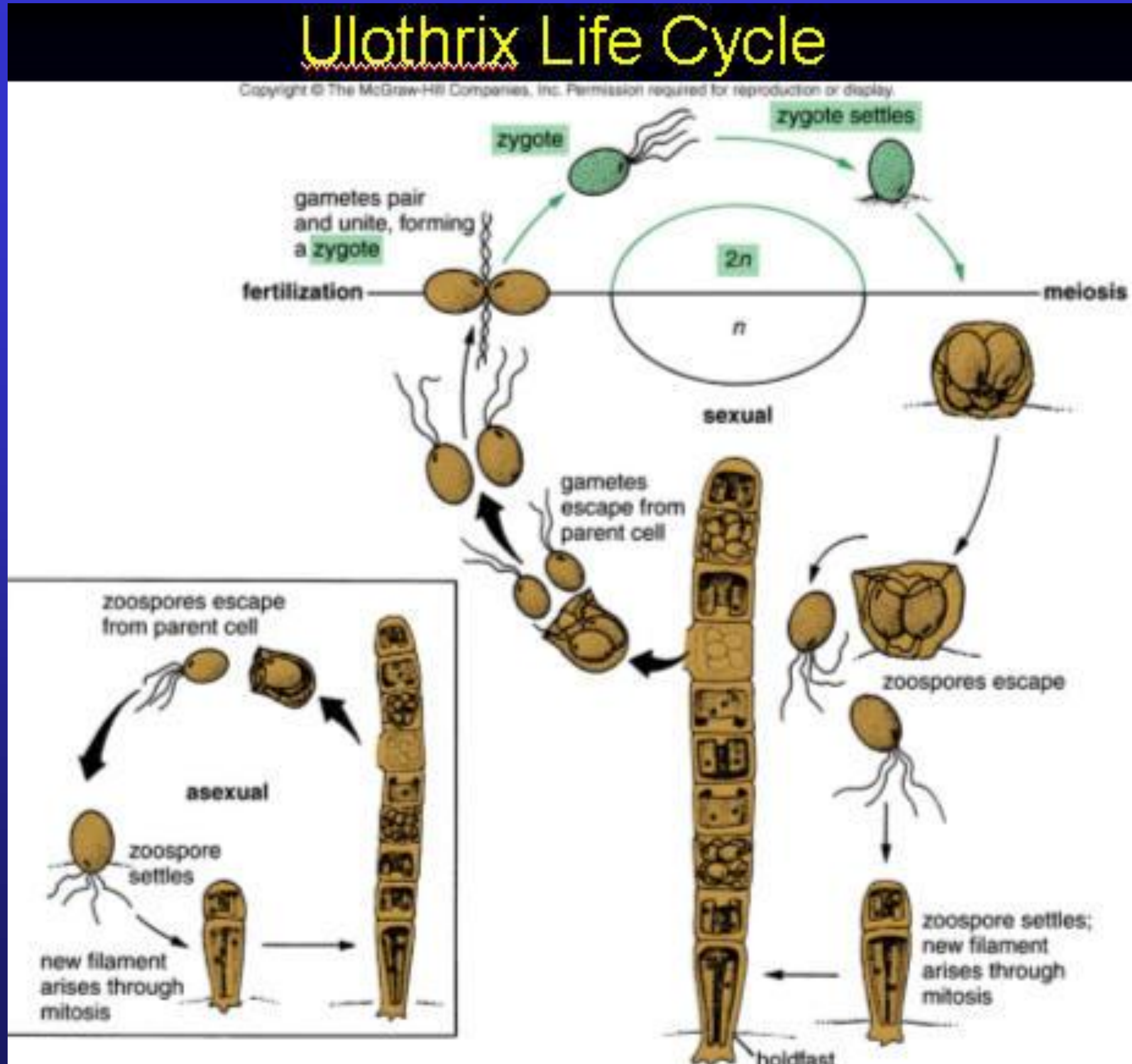


Ulothrix

haplontic cycle

izogamy

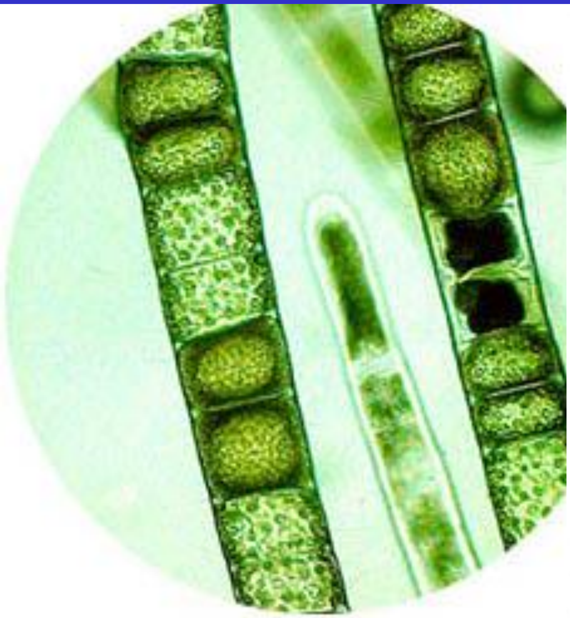
heterothalism

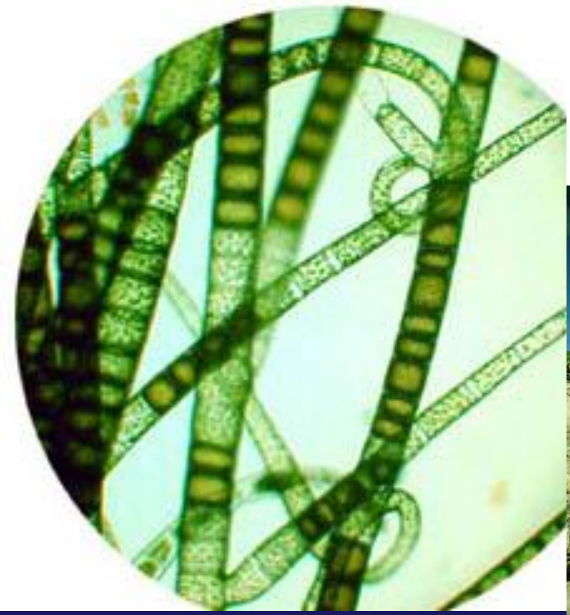


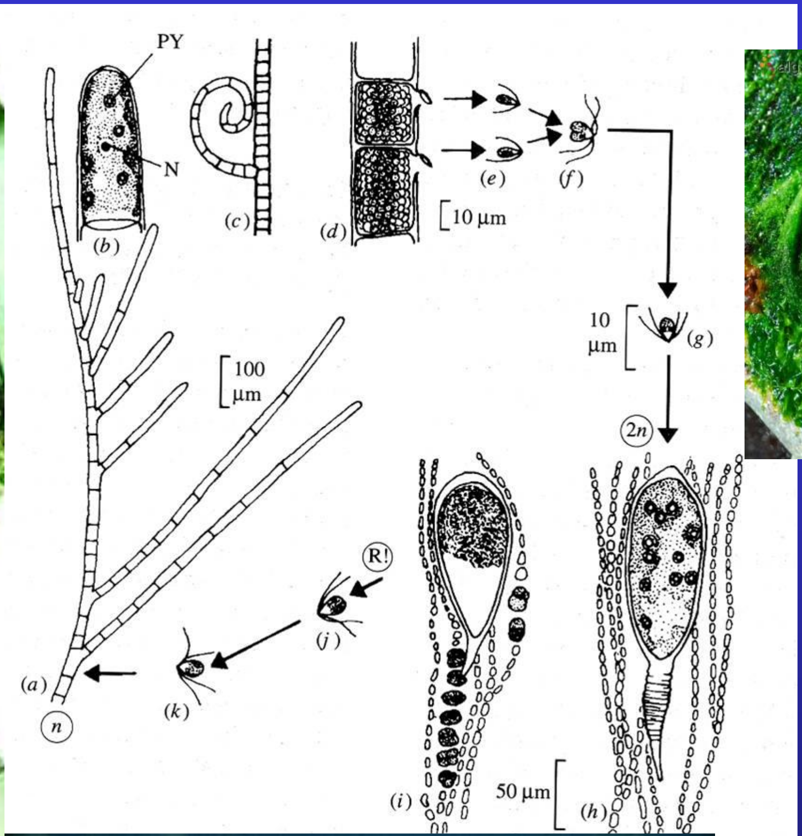
Ulothrix zonata

Spongomorpha

izogamy;
apical growth







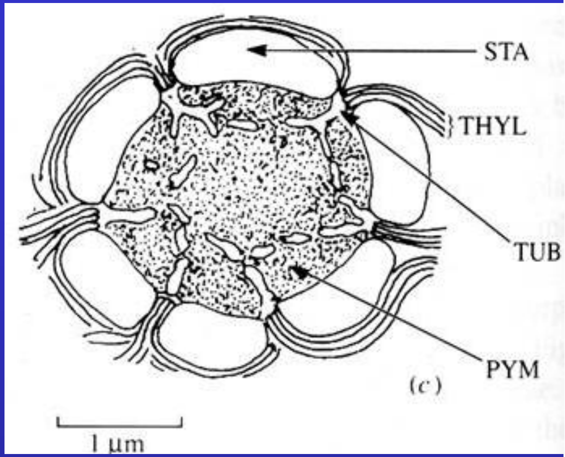
uninuclear cells

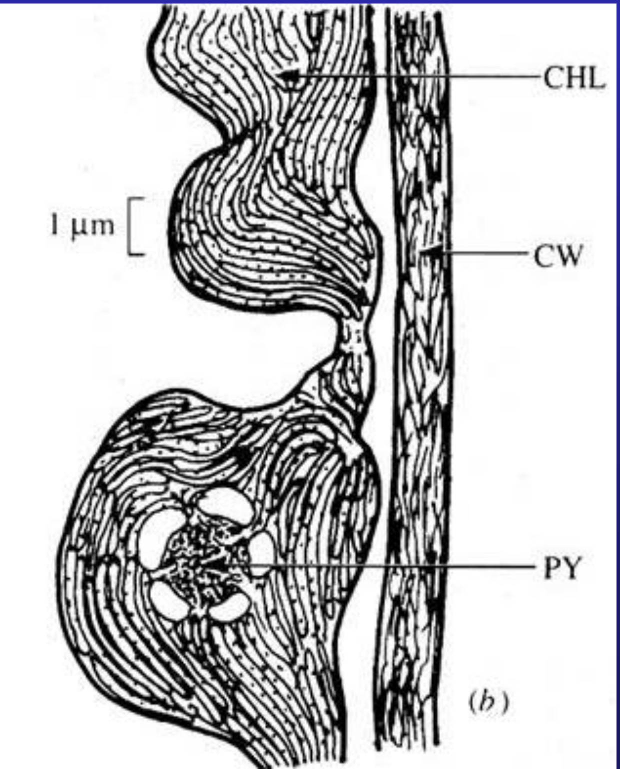
codiolus stage resembles *Petrocelis* (red alga)

eulitoral of North Altantic

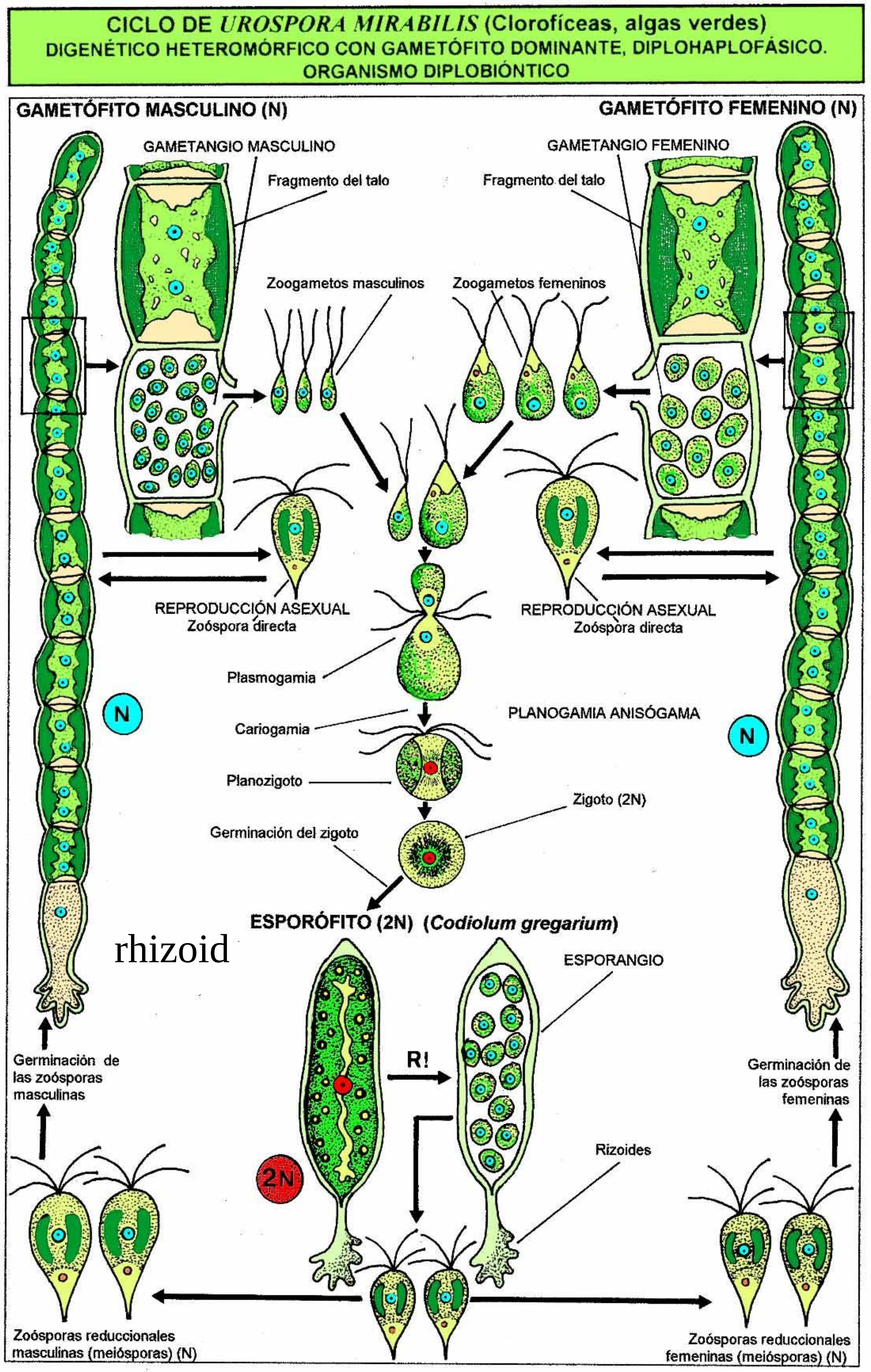
Urospora

anizogamy
heterothalism

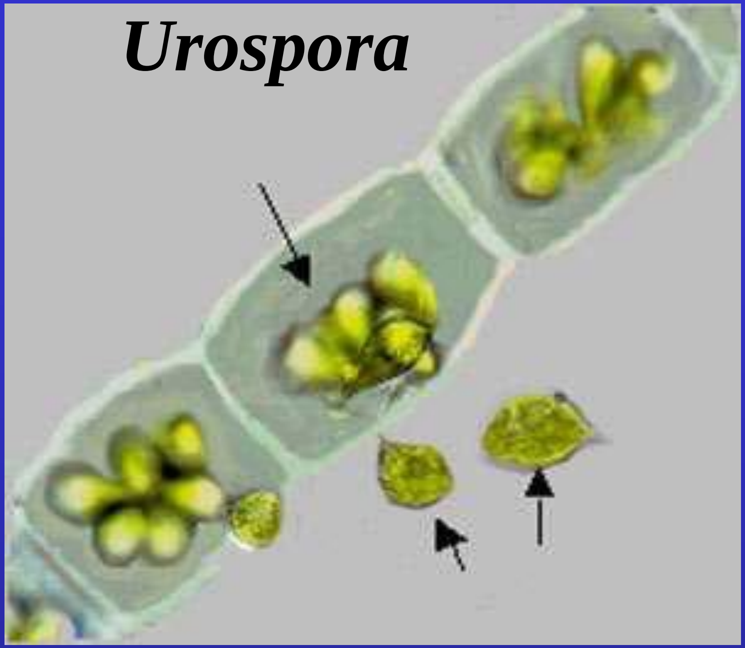




multinucleate
cells

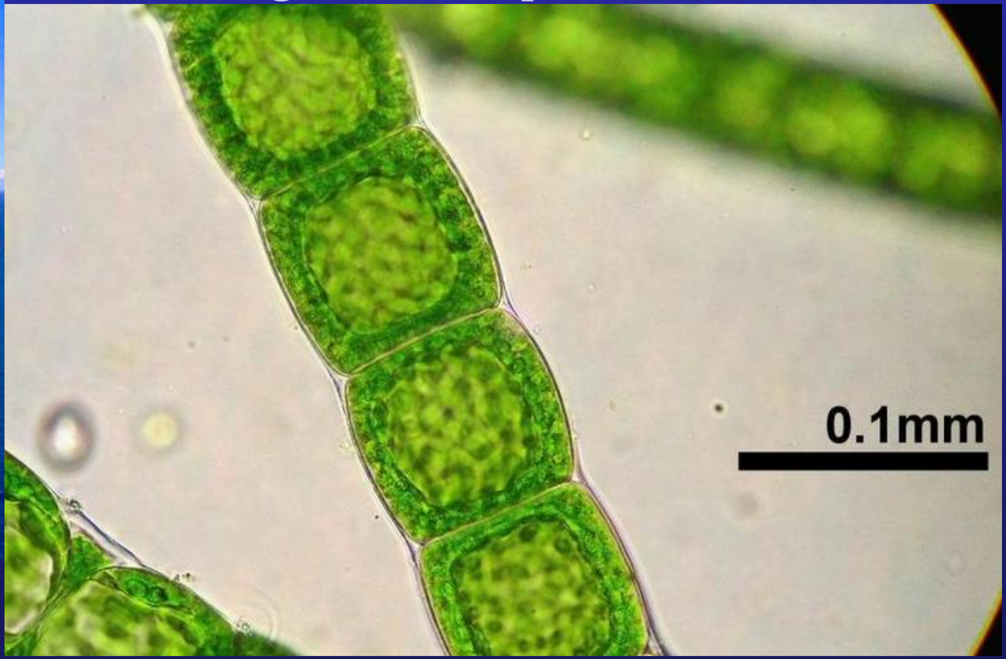


rhizoid

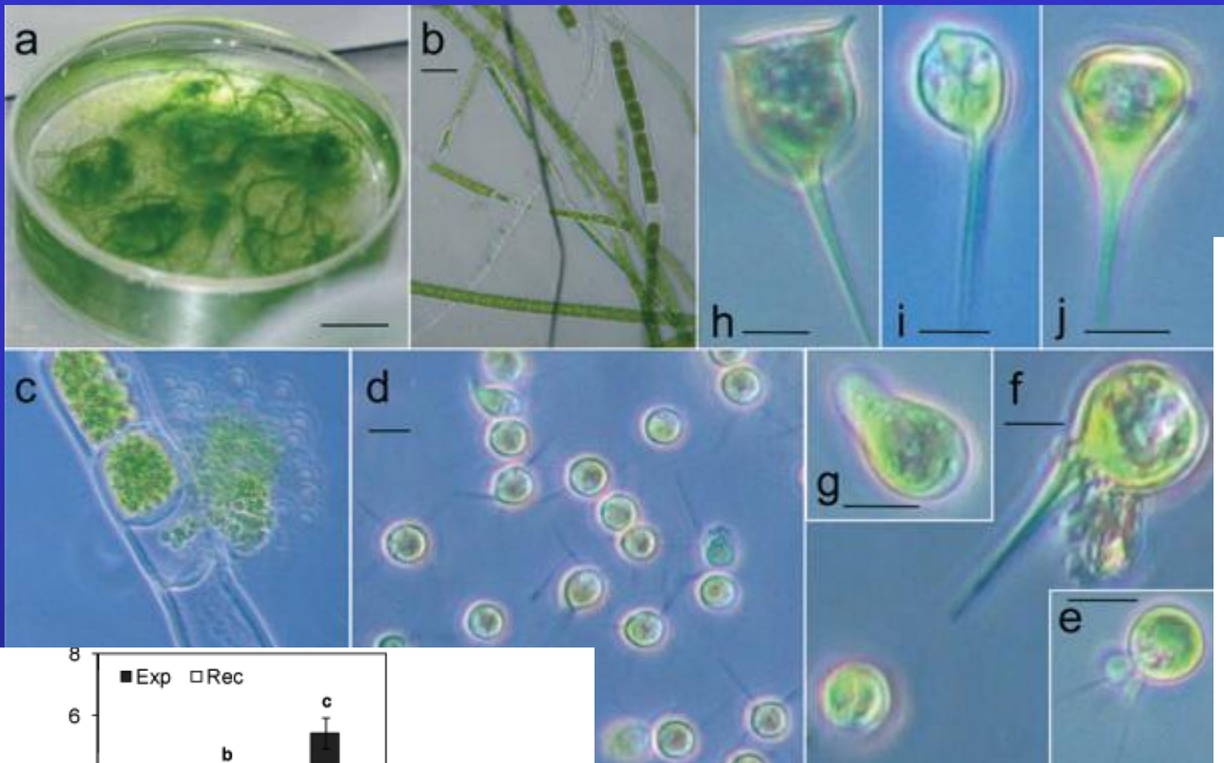


4-flagellate zoospores

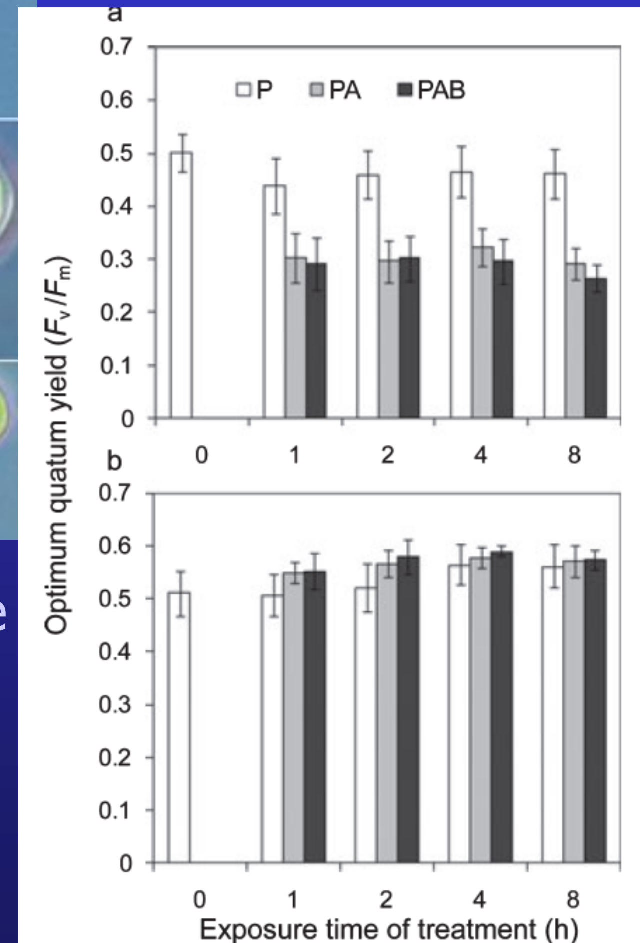
Arctic and Antarctic sea

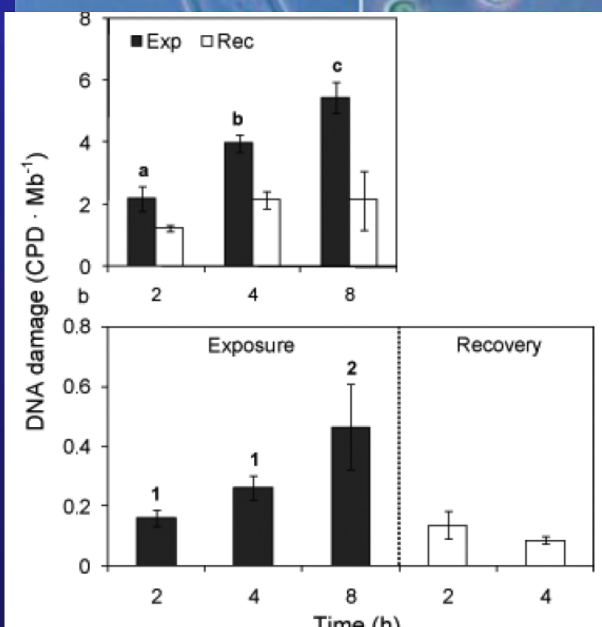


Sensitivity of Antarctic Urospora to UV (UVA, UVB) radiation



Gametophytic filaments and propagules (zoospores and gametes)



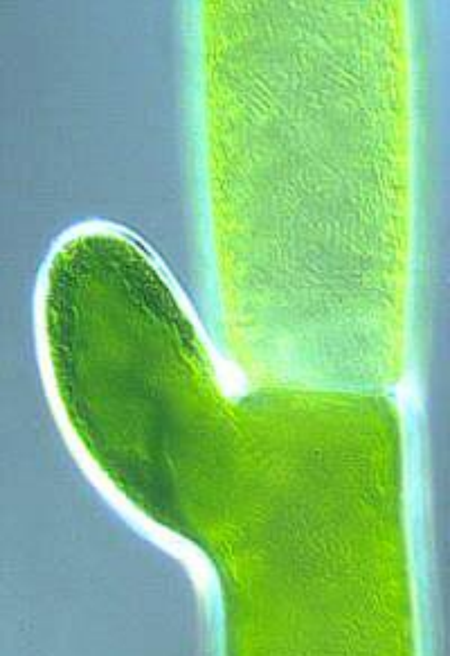


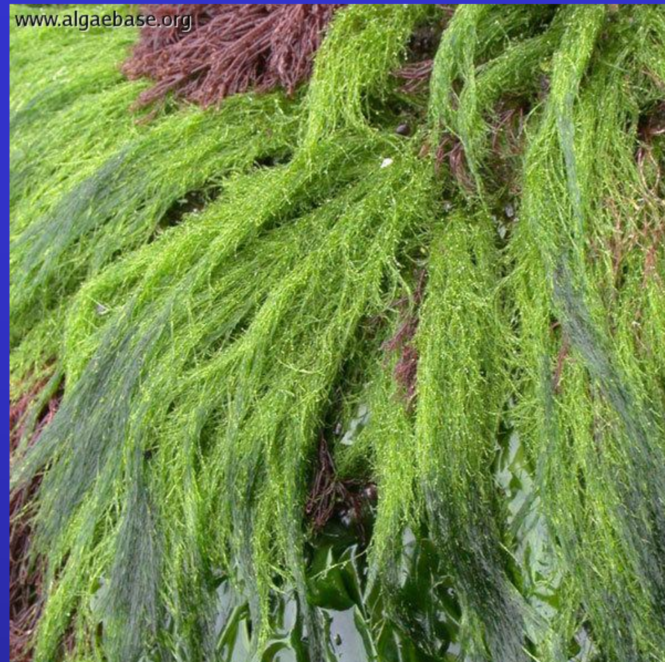
propagules slightly more sensitive, fast recovery

filaments with thick cell walls

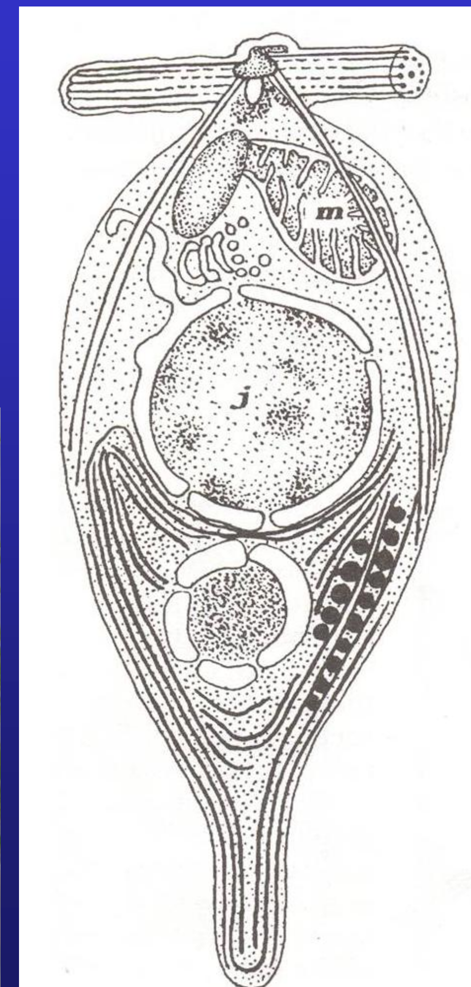
Roleda et al. 2009

Acrosiphonia



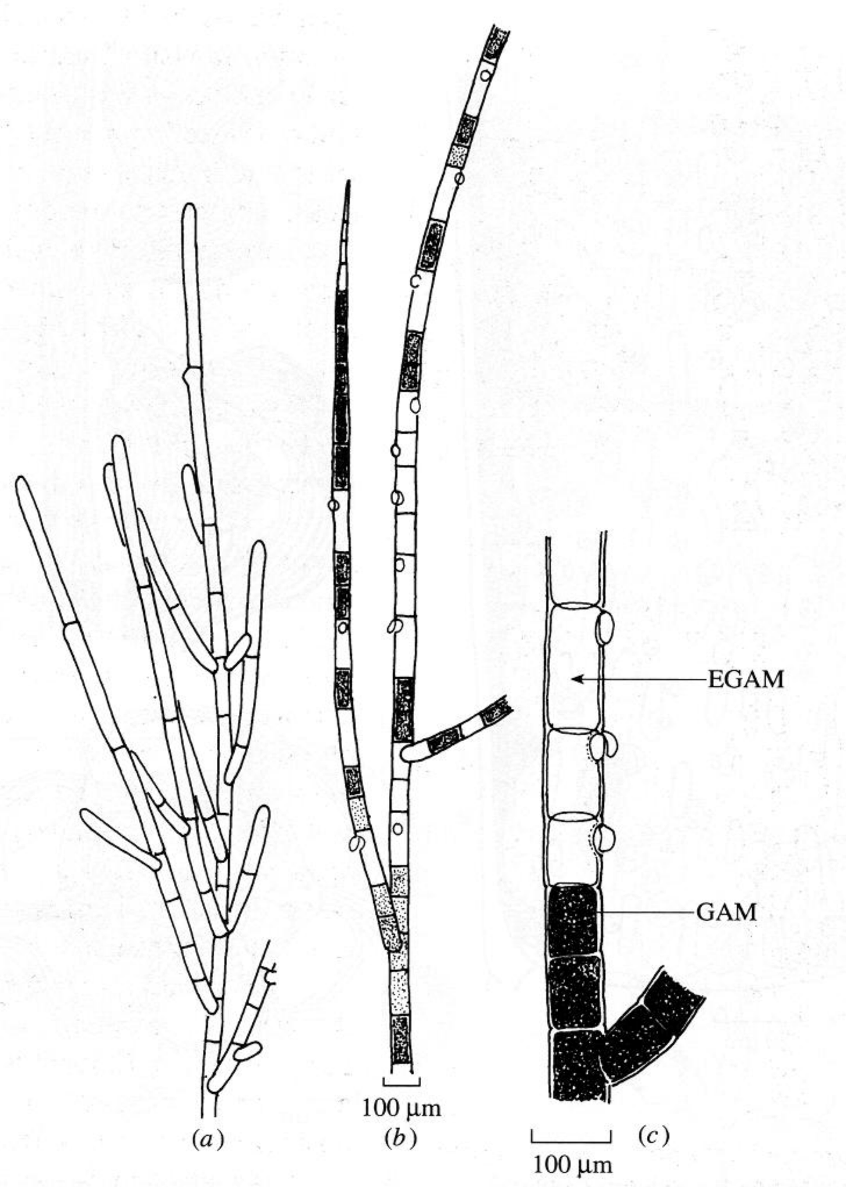


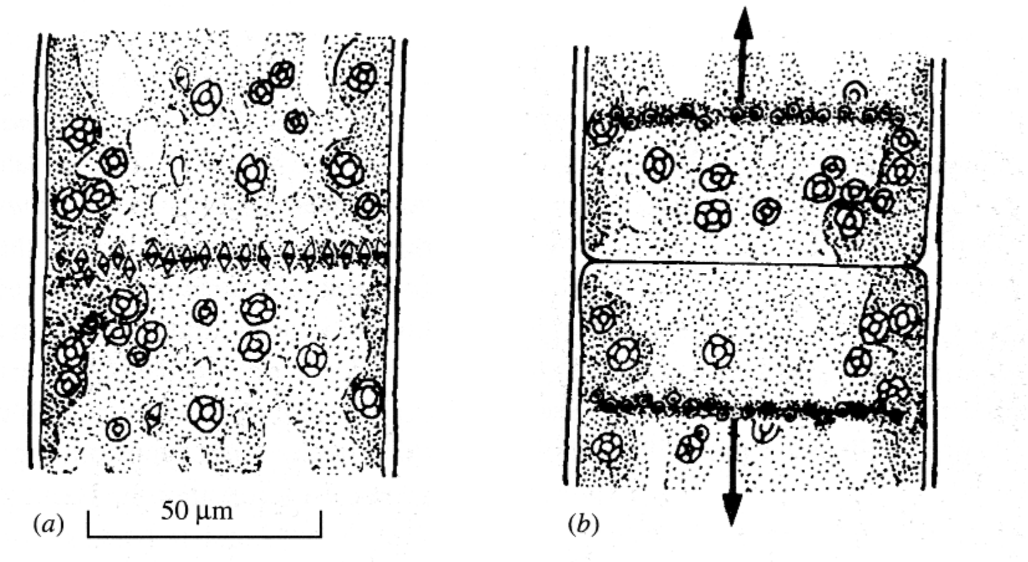
2-flagellate gamete



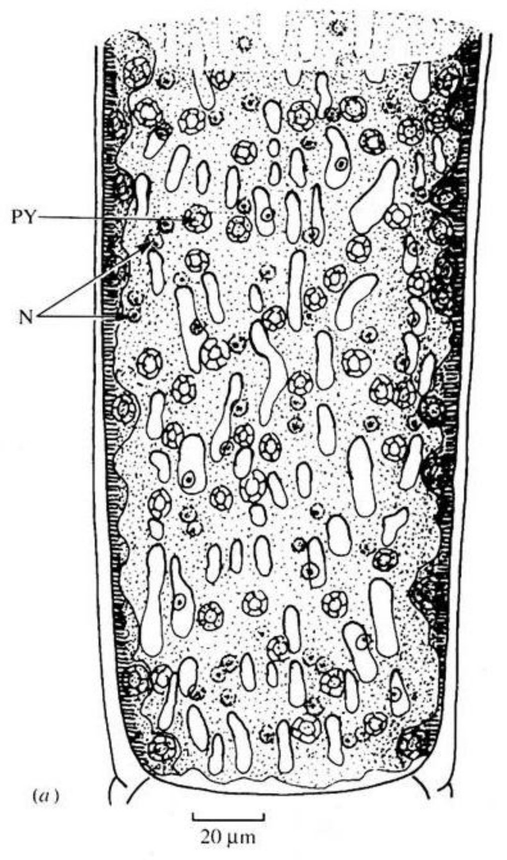
Branched filament, multinucleate cells. Epilithic in temperate and polar regions

Acrosiphonia



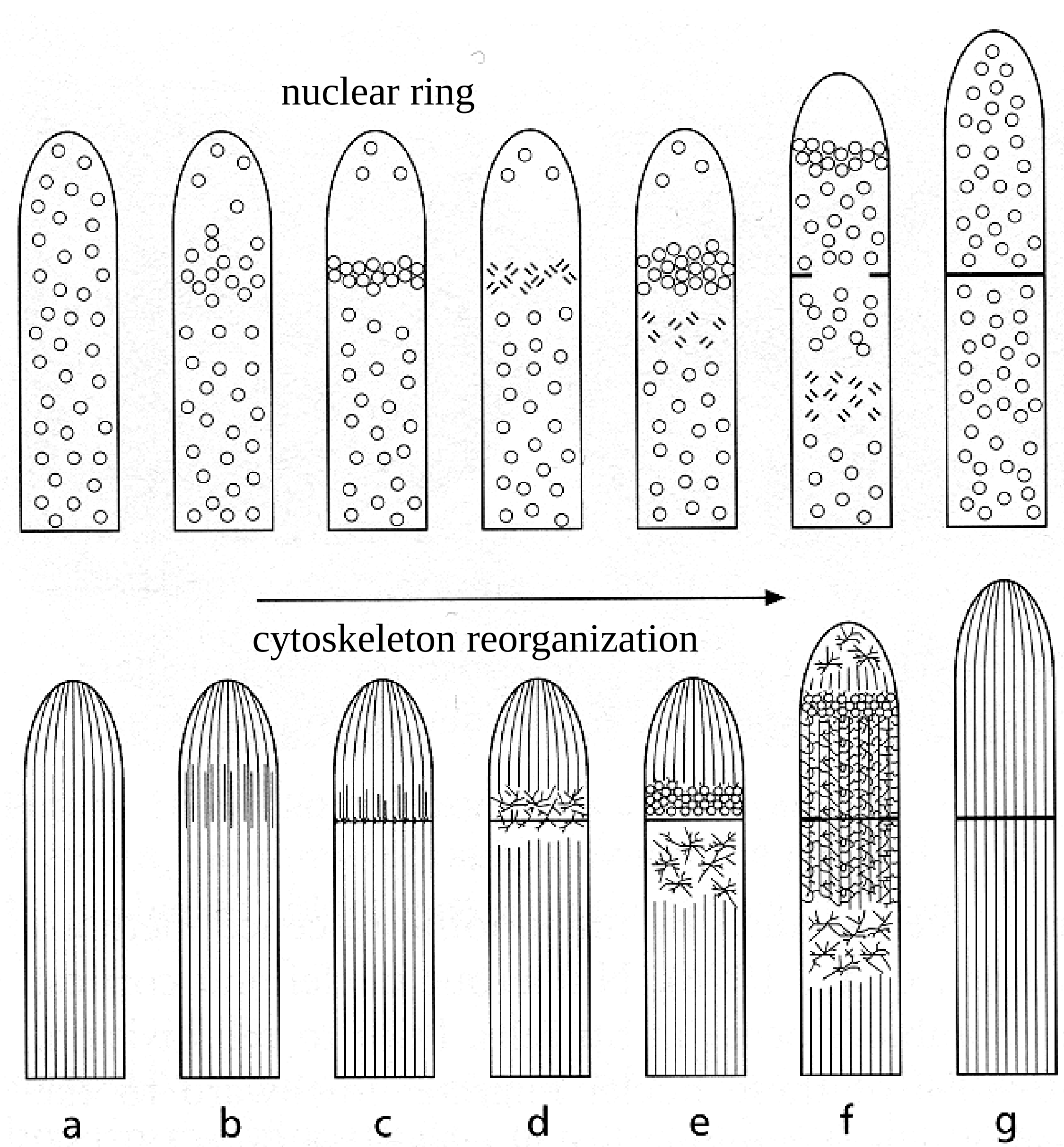


synchronous mitosis



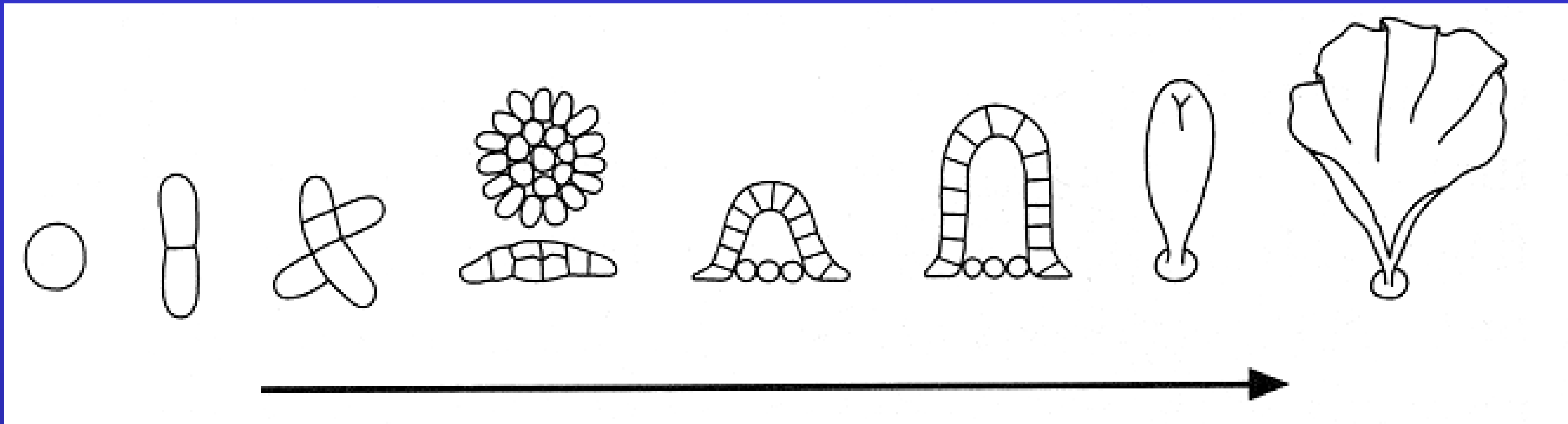
perforated chloroplast

Acrosiphonia



behaviour of nuclei and microtubuli during mitosis

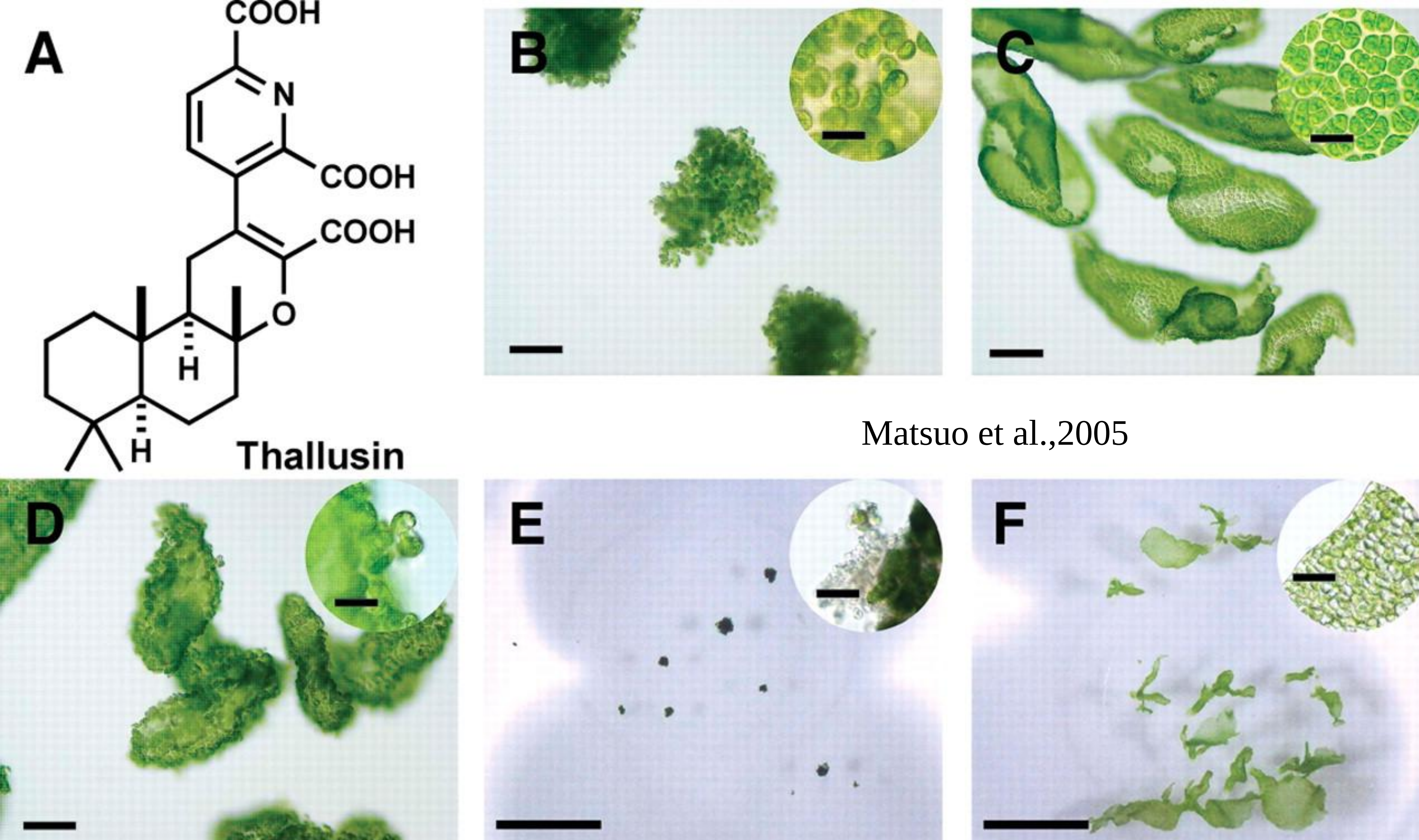
Monostroma



thallus formation from the short filaments

monostromatic thallus



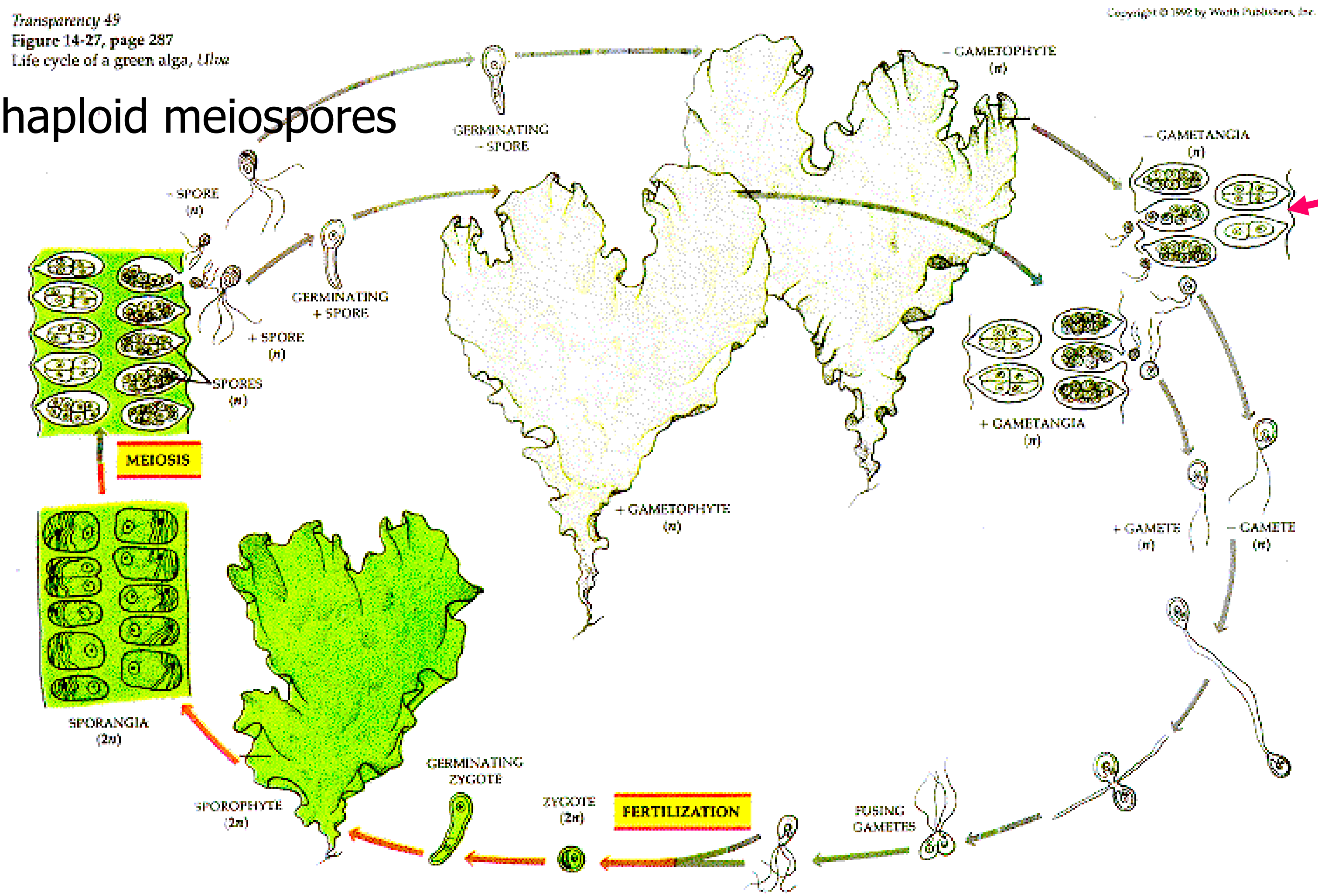
Matsuo et al.,2005

Fig. 1. (**A**) The structure of thallusin. (**B**) Morphology of axenic *M. oxyspermum*. (**C**) The effect of thallusin on *M. oxyspermum* (an initial concentration of 1 ng ml–1). (**D**) Dedifferentiation given a lack of thallusin (an initial concentration of 1 pg ml–1). Inset: Protruding cells from disintegrating thalli. (**E**) Small callus-like morphology of *U. pertusa*, after 2 months of cultivation under aseptic conditions. Inset: Colorless protrusions from the lateral cell walls. (**F**) The effect of thallusin (1 ng ml–1) on *U. pertusa*. Inset: A foliaceous distromatic blade.

Řád: Ulvales

From the transparencies to accompany Peter H. Raven, Ray F. Evert, and Susan E. Eichhorn, *Biology of Plants*, 5th edition. Worth Publishers, New York, 1992. Reproduced with permission.

haploid meiospores



zygote germinates immedialely

Ulva

Ulvaria

monostromatic thallus (single layer of cells)

temperate regions of the Northern hemisphere
North Atlantic, North Pacific

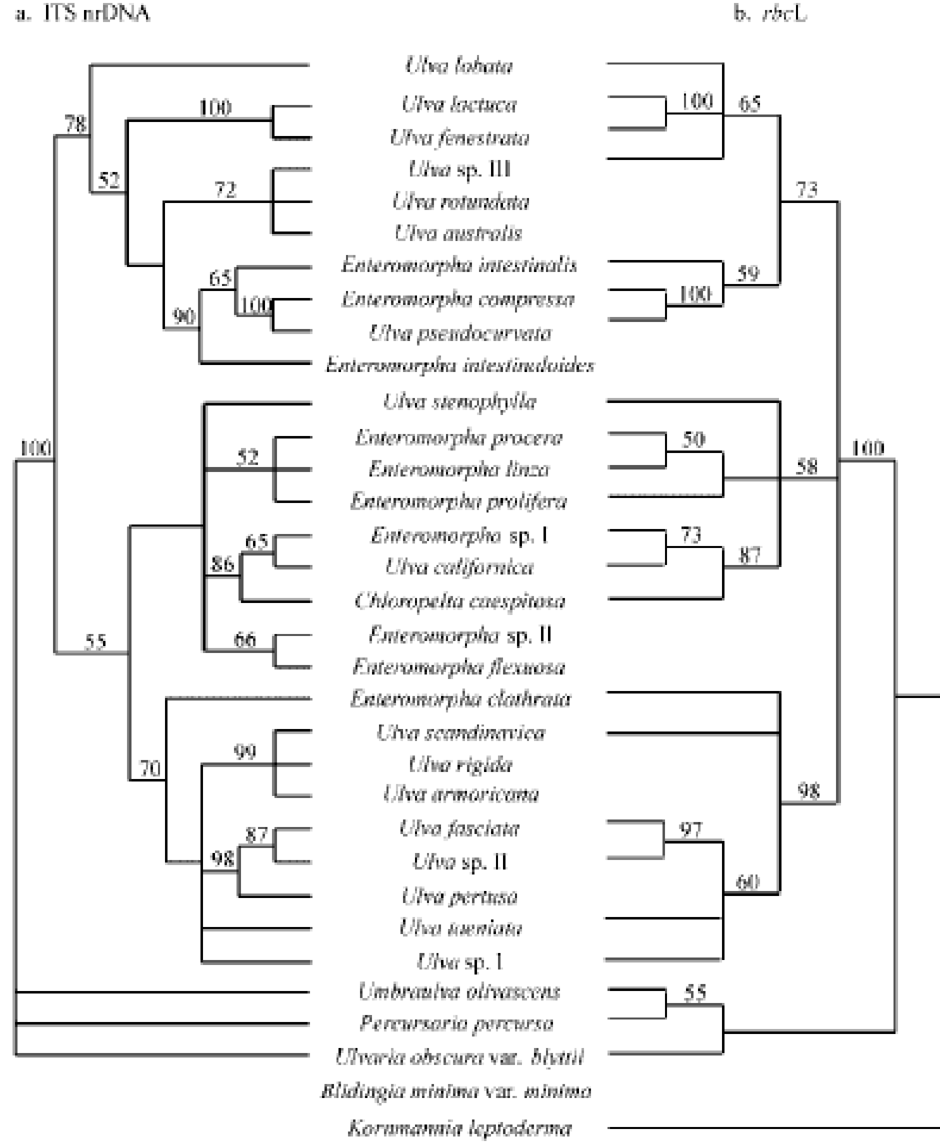
Enteromorpha=Ulva

Hayden et al. 2003 synonimize both genera

All after Entwisle et al. (1997)

Table 3. Characters used to delimit species of *Ulva* and *Enteromorpha* based on Koeman and van den Hoek (1981) and Bliding (1963, 1968). Characters noted with (E) and (U) are used only in *Enteromorpha* and *Ulva*, respectively.

Character
Gross morphology, including colour and texture of mature plant
Structure of plant base
Arrangement and shape of cells in surface view
Structure of branch tips (E)
Number of pyrenoids per cell
Shape of chloroplast in surface view
Cell size at base, middle and apex of thallus
Height-to-width ratio of cells in cross section (U)
Thallus thickness (U)
Morphology of young germling
Mode of reproduction
Ecology



Hayden et al. 2003. Linnaeus was right all along: *Ulva* and *Enteromorpha* are not distinct genera. *European Journal of Phycology*. 38: 277-294.

Carl Linné

(1719-1772)

CAROLI A LINNÉ
EQUIT. AURAT. DE STELLA POLARI,
ACAD. PARIS. MEMBR. &c.

SYSTEMA
NATURÆ
PER
REGNA TRIA NATURÆ,
SECUNDUM
CLASSES, ORDINES,
GENERA, SPECIES,

(1767)

1204. TREMELLA. *Fructificationes* vix manifeſtæ, in corpore gelatinoſo.
1625.

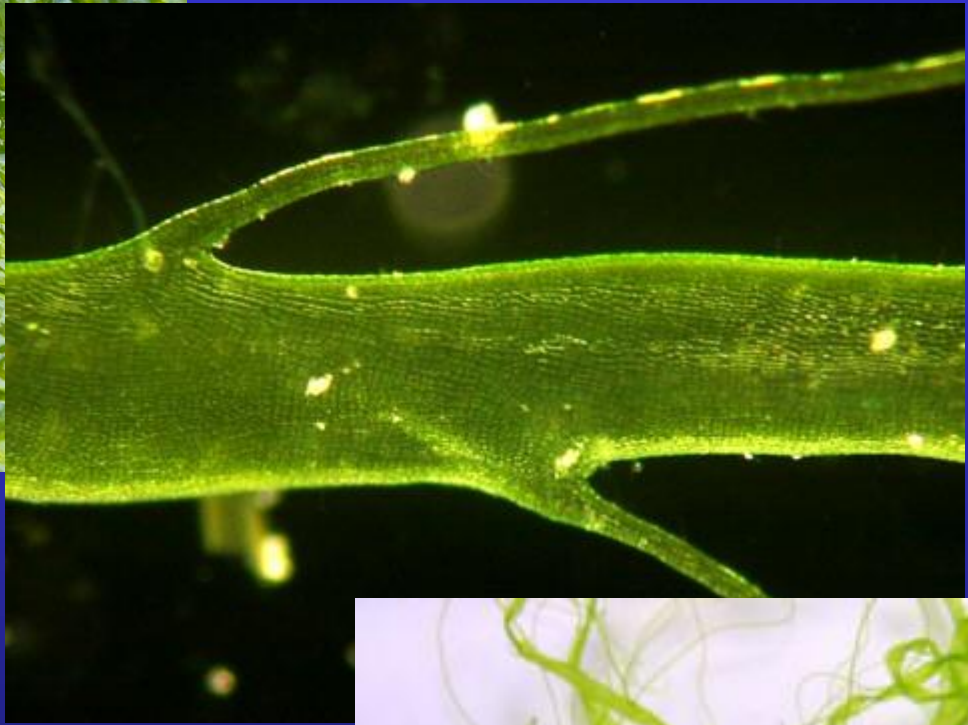
juniperin. 1. T. ſeſſilis membranacea auriformis fulva.
Noſtoc. 2. T. plicata undulata.
lichenoides. 4. T. erecta plana: margine criſpo lacinulato. *Dill. muſc. t.* 19. *f.* 32, 34, 35.
verrucoſa. 5. T. tuberculoſa ſolida rugoſa. *Dill. muſc. t.* 10. *f.* 16.
difformis. 8. T. ſubrotunda ſinuata difformis gelatinoſa.
hemiſph. 6. T. hemiſphærica ſparſa.
purpurea. 7. T. ſubgloboſa ſeſſilis ſolitaria glabra.
adnata. 9. T. rotunda imbricata livida.

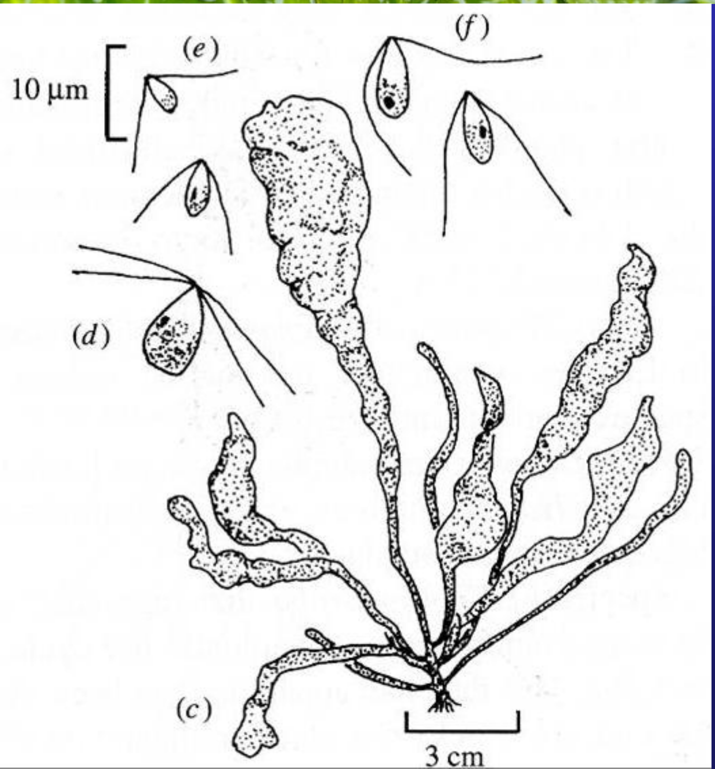
1205. FUCUS. MASC. *Veſiculæ* villis intertextæ.
1626. FEM. *Veſiculæ* adſperſæ granis immerſis apice prominulis. *Sem.* ſolitaria.

ovarius. 36. F. caule filiformi ramoſo, fol. confertis ovatis fornicatis. *Habitat in O. Aſiatico.* Folia *conferta in racemum, retrorſum fornicata, membranacea, purpuraſcentia, parva. Fructificationes non vidi.*

only 5 algal genera discerned (Tremella, Fucus, Ulva, Conferva, Corallina + Volvox (=animal like plant)

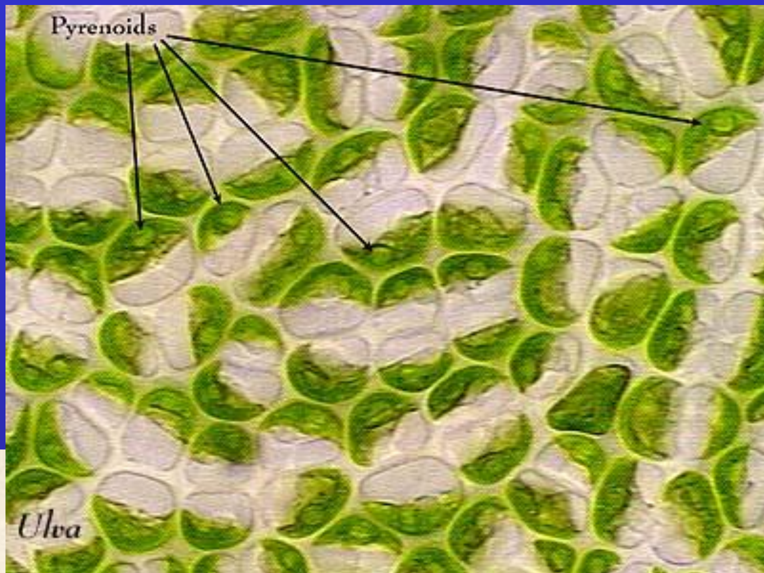
Enteromorpha=Ulva





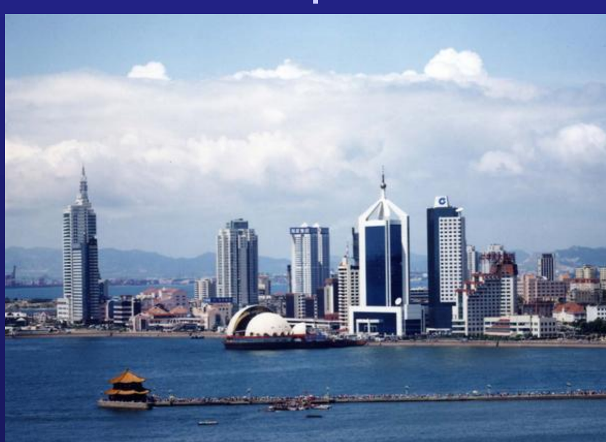
release of gametes influenced by lunar cycle

Ulva



(Qingdao on 18.7.2011)
South China

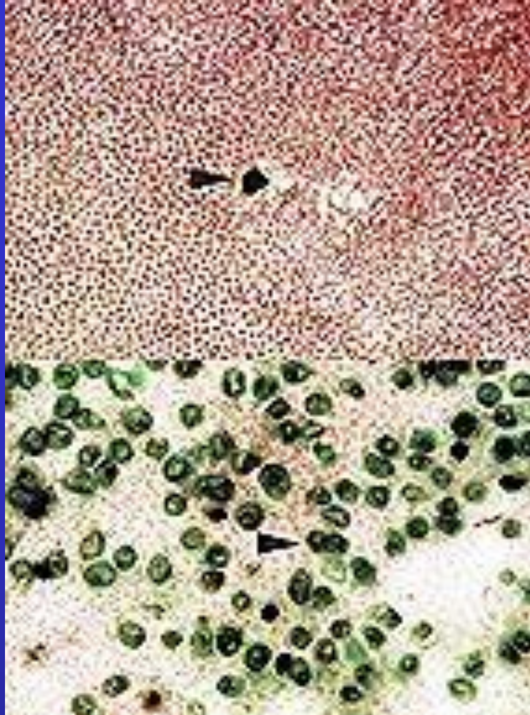
Going Green: Beach Carpet



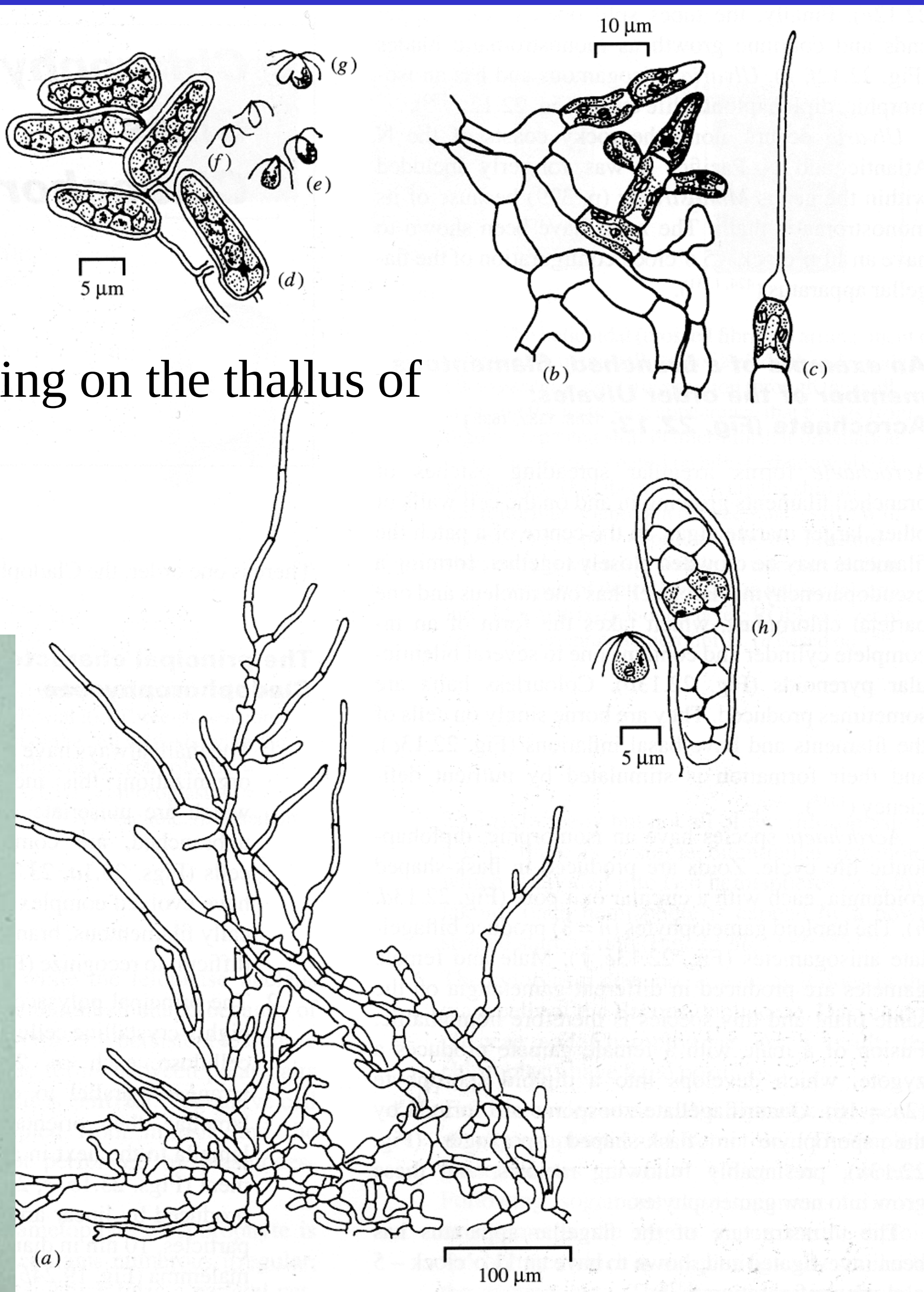
2013

1. 7. 2008 - Sailing course for the Olympic Summer Games. Qingdao, China

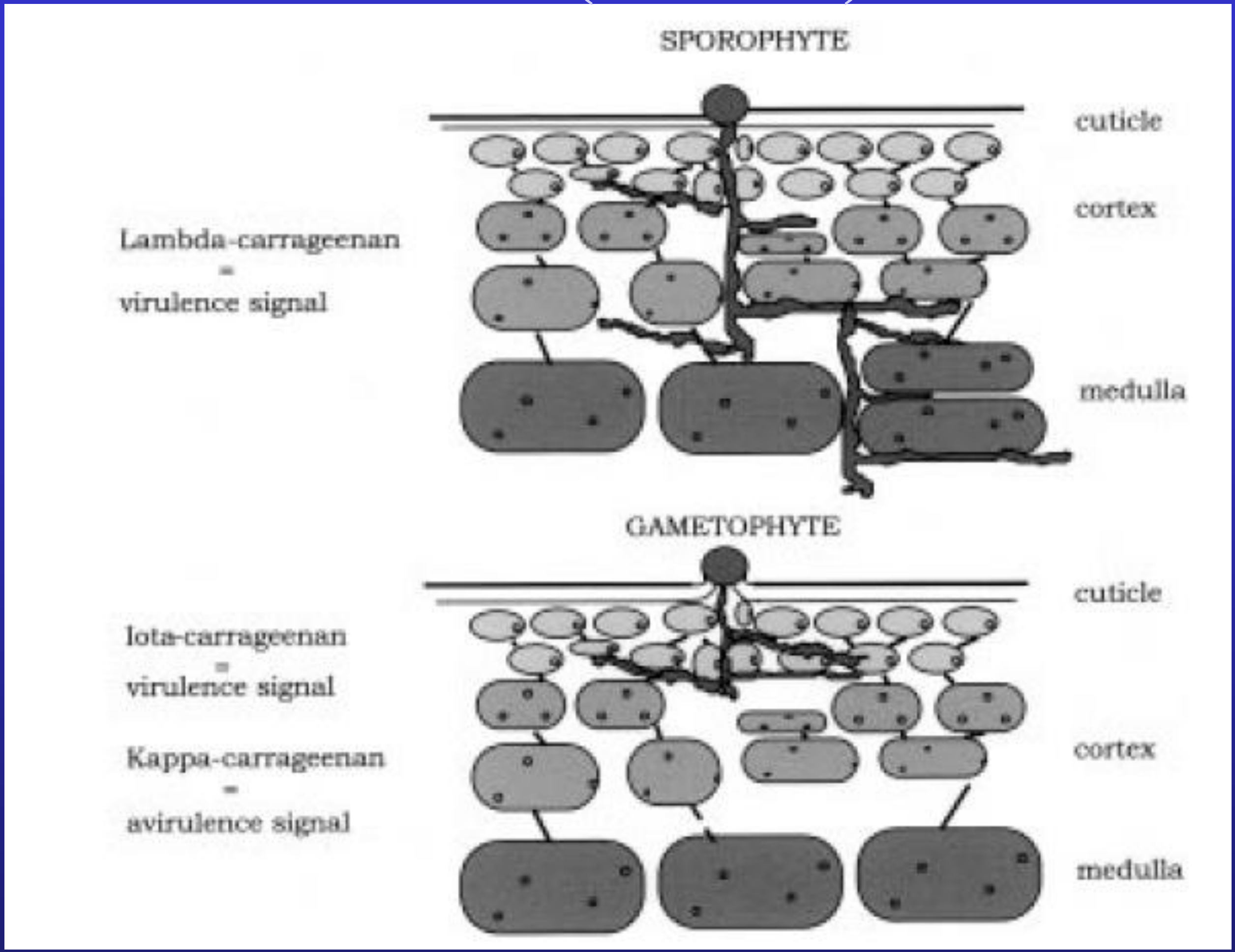
Acrochaete - parasite



Acrochaete growing on the thallus of *Chondrus*



The virulence of *Acrochaete* mediated by CW composition of the host (*Chondrus*)



susceptible to infection

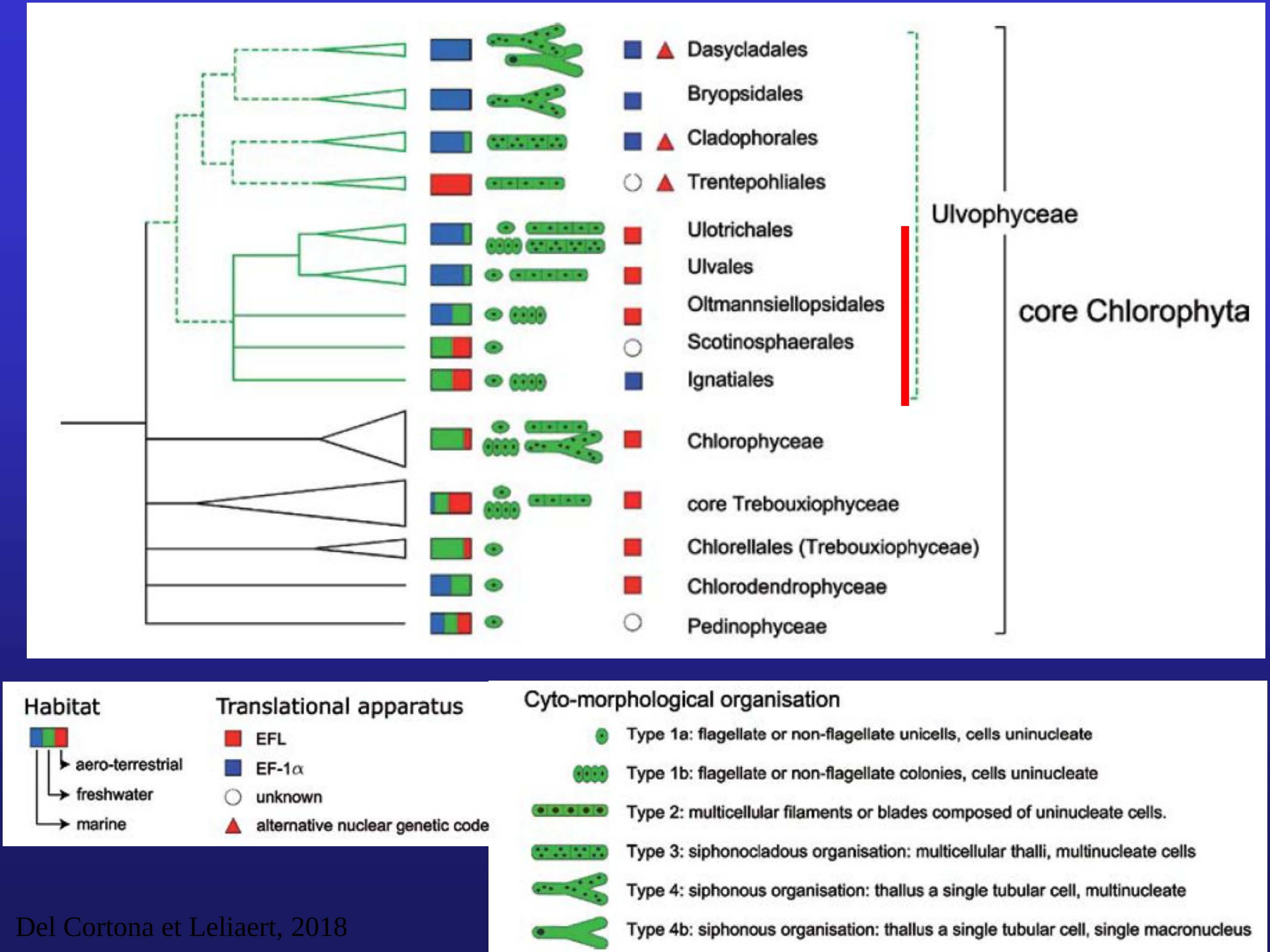
resistant

In this pathosystem,the host gametophytes are resistant to the pathogen, whereas the sporophytic generation is susceptible to infection. The virulence of the green algal pathogen is mediated by the recognition of carrageenan oligosaccharides released from its red algal host: kappa-carrageenan oligosaccharides inhibit *A. operculata* virulence while lambda-carrageenan oligosaccharides enhance its pathogenicity. Bouarab et al. 2004

Induced defence of red algae against pathogens

We investigate the alga/pathogen interaction in the system of the red alga Chondrus crispus (left on top) and the green algal pathogen Acrochaete operculata (below left), which is able to grow within the tissue of the red algal host. This process, called endophytism, can be inhibited during certain developmental phases of C. crispus. During the resistant, gametophytic, phase of the life cycle, C. crispus can recognise the attacker and kill it by an immediate release of hydrogen peroxide. We found that carrageenans from the red alga induce the release of asparagine from the green algal parasite. The free amino acid itself acts as a substrate for an amino acid oxidase of the host that releases micromolar amounts of hydrogen peroxide, sufficient to contain the attacker. The aim of a related collaborative project (European Union EPIFIGHT) is to understand the biological

carragenans induce the release of asparagine (Asn) from Acrochaete
Free Asn – substrate for amino acid oxidase of Chondrus – releas of
H2O2 – enough to contain/kill the attacker



Del Cortona et Leliaert, 2018