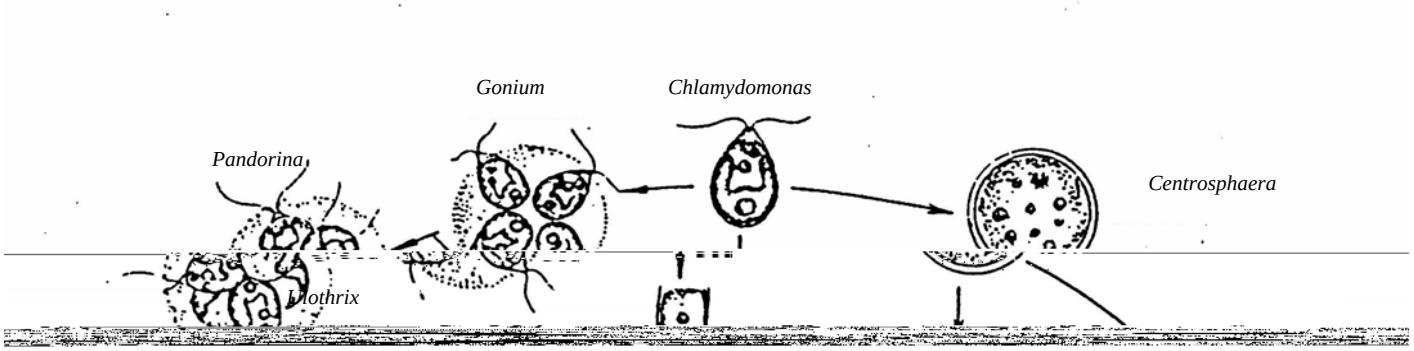


Volvox

Chaetomorpha

Stigeoclonium

Derbesia

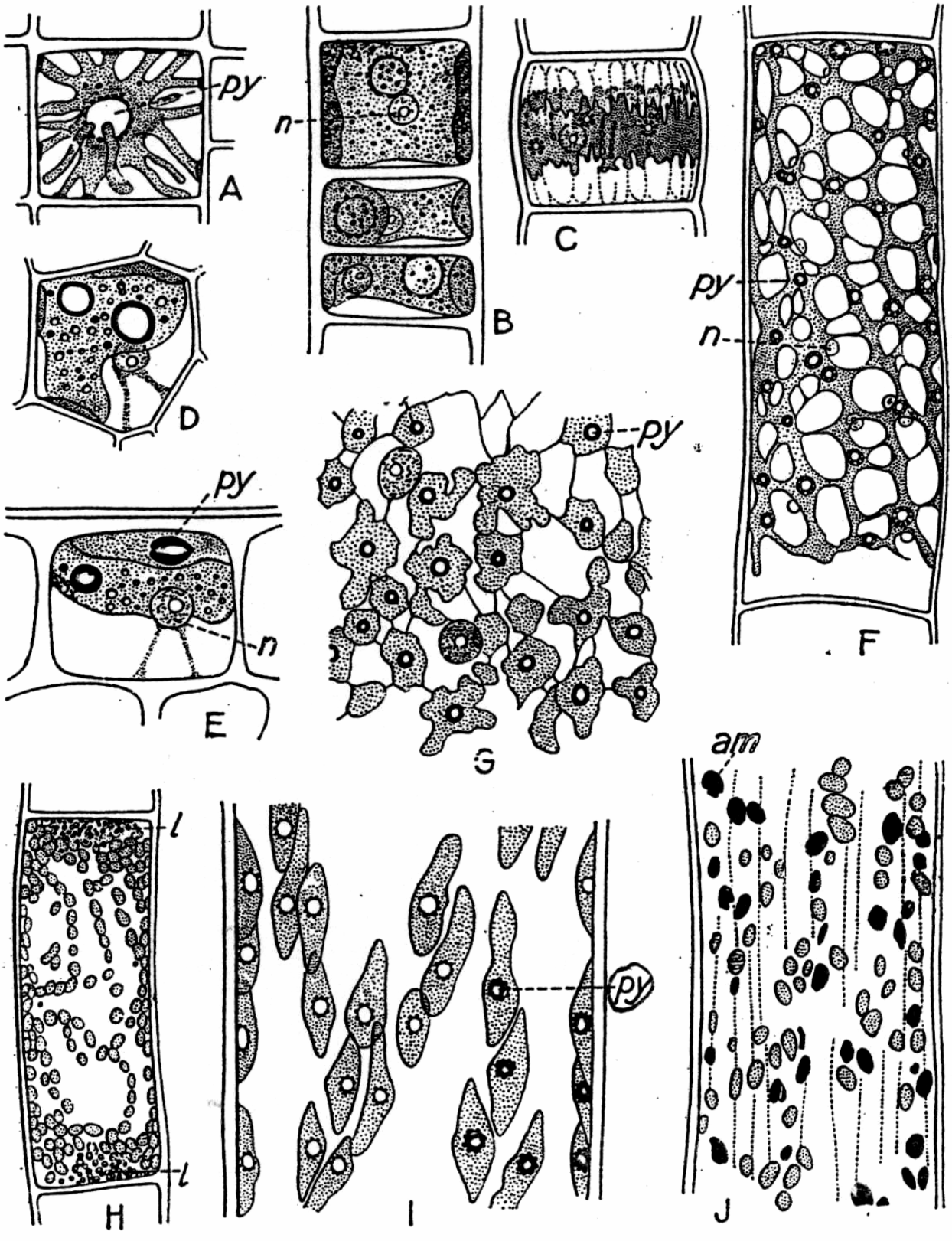
Monostroma

Codium

Ulva

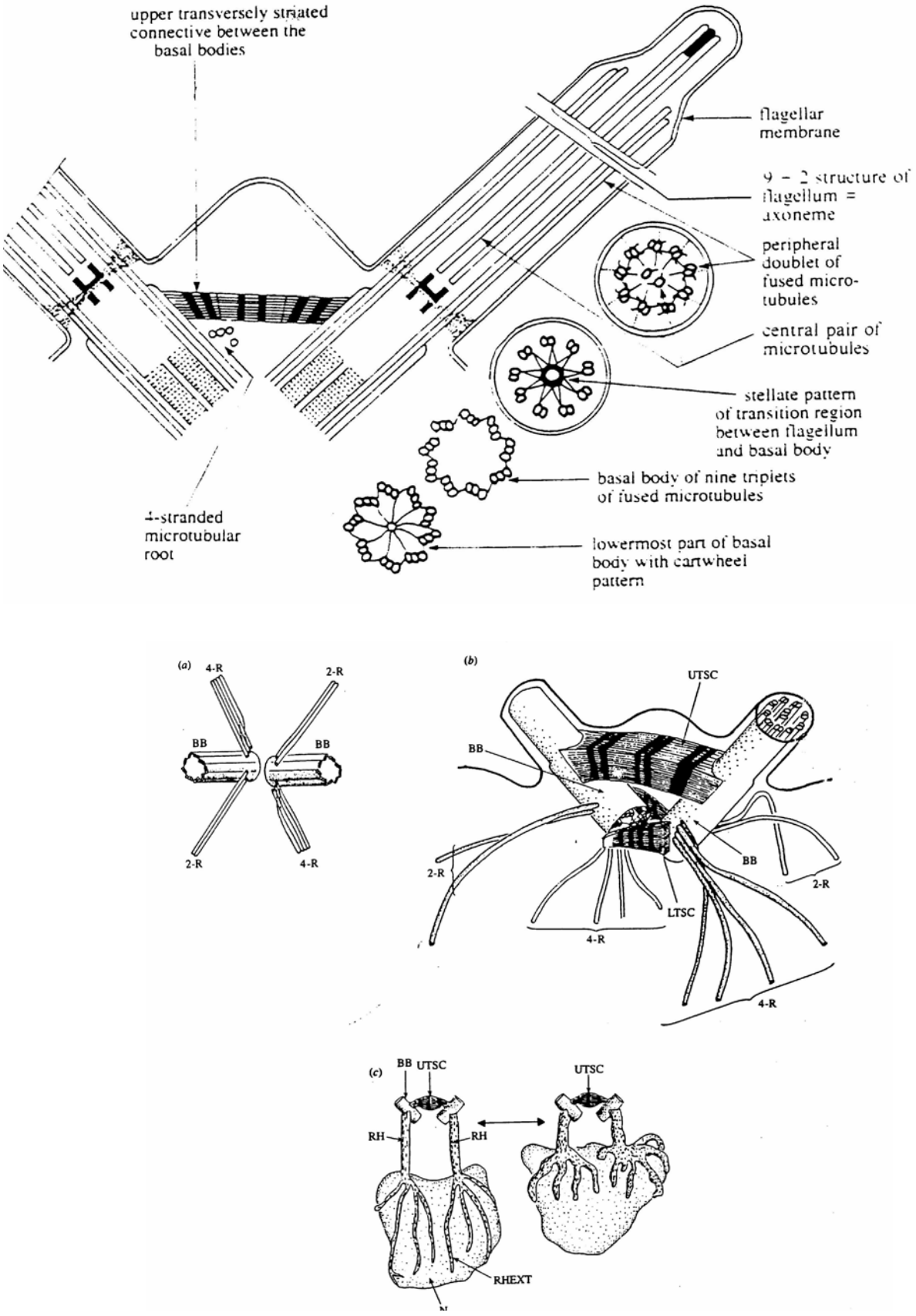
Cladophora

Fritschiella

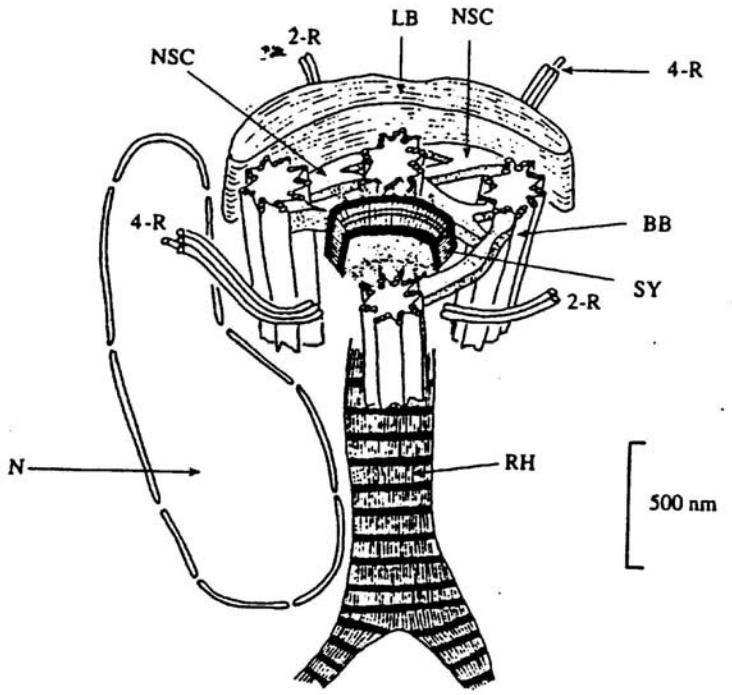


— *Morphologie des chloroplastes des Chlorophycées. A, Prasiola*; *B, Ulothrix*; *C, Draparnaldia*; *D* et *E, Ulva* (de face et de profil); *F, Acrosiphonia*; *G, Siphonocladus*; *H, Trentepohlia*; *I, Derbesia*; *J, Udotea.* — *n*, noyau; *py*, pyrénoïde; *am*, amidon; *l*, gouttelettes lipidiques (Original, sauf *C* d'après SCHMITZ).

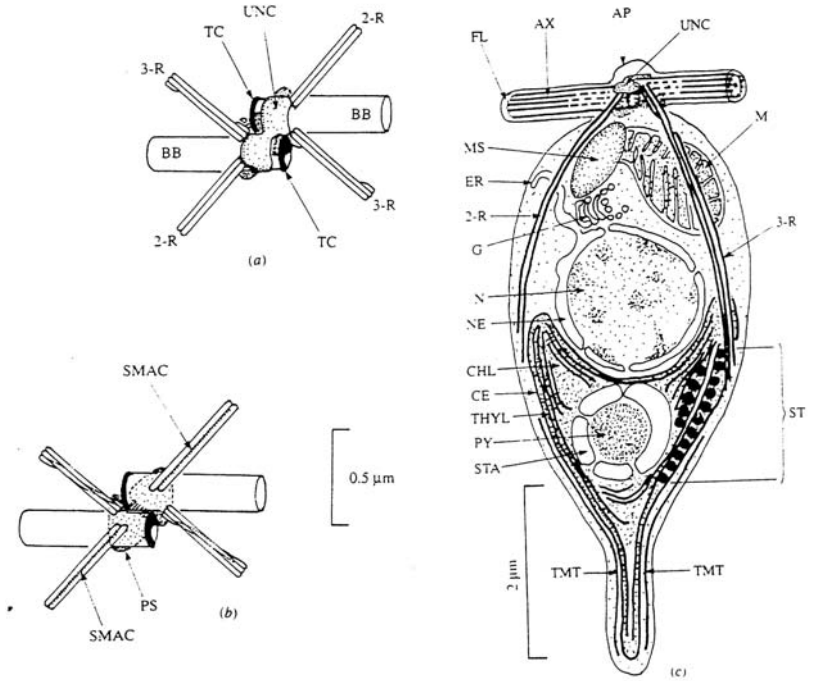
Feldmann, 1978



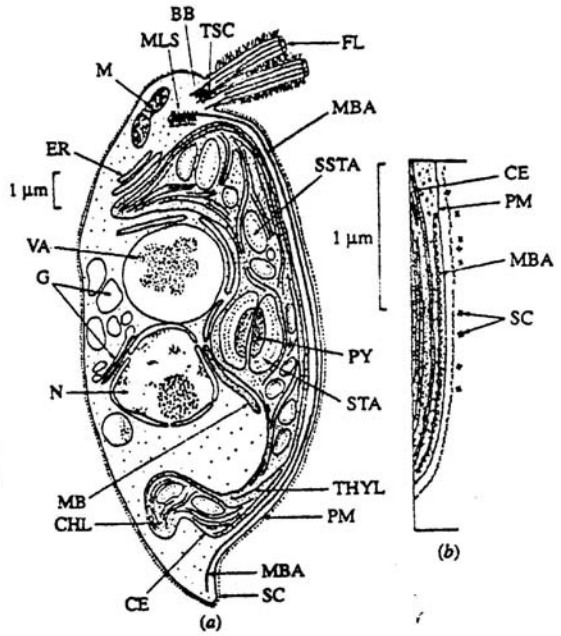
The flagellar apparatus of *Chlamydomonas reinhardtii*, a zoid of the cruciate 1 o'clock – 7 o'clock type. (*a*) Top view, showing the arrengement of the basal bodies and the four microtubular roots. (*b*) Three-dimensional view of the flagellar apparatus, as seen from the side. (*c*) The two rhizoplasts connecting the basal bodies to the nucleus, relaxed (left) and contracted (right). BB = basal body; LTSC = lower transversely striated connective; N = nucleus; RH = rhizoplast; RHEXT = extension or branch of rhizoplast; UTSC = upper transversely striated connective; 2-R = two-stranded microtubular root; 4-R = four-stranded microtubular root. Van den Hoek *et al.*, 1995



The flagellar apparatus of *Pyramimonas*, a zoid of the cruciate prasinophycean type. BB = basal body; LB = lateral fibrous band; N = nucleus; NSC = non-striated connective; RH = rhizoplast; SY = synistosome; 2-R = two-stranded microtubular root; 4-R = four-stranded microtubular root. Van den Hoek *et al.*, 1995

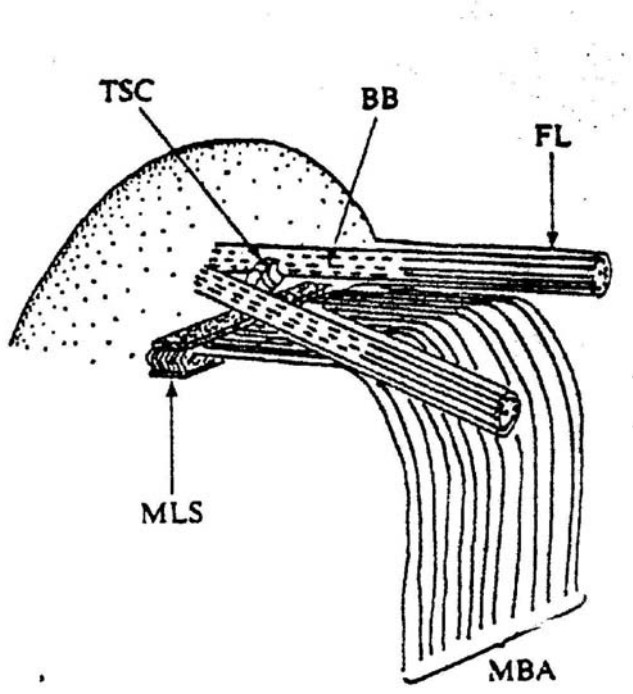


Acrosiphonia gamete, azoid of the cruciate 11 o'clock – 5 o'clock type. (*a*) Top view of the flagellar apparatus: the basal bodies are shown as cylinders. (*b*) As (*a*), but with the upper non-striated connective removed and other structures made transparent, to show the positions of the lower parts of the flagellar apparatus. (*c*) Longitudinal section of the zoid, base on EM observations. Van den Hoek *et al.*, 1995



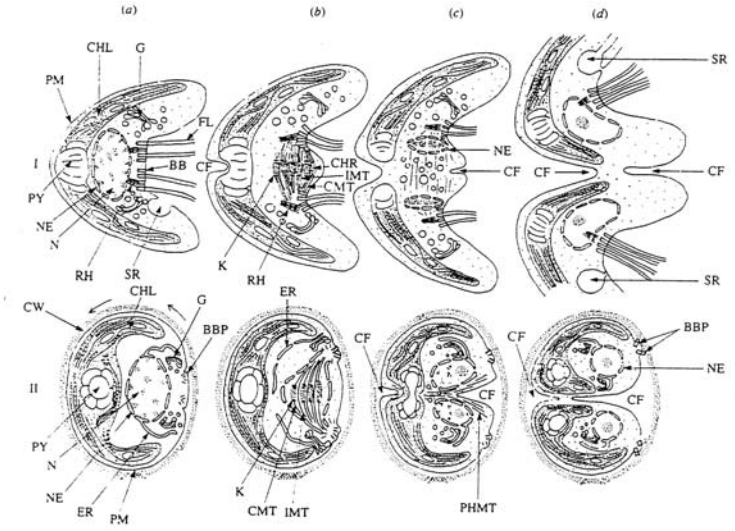
Chaetosphaeridium zoospore: a zoid of the unilateral type. (*a*) Longitudinal section, based on EM observations. (*b*) Transverse section through the cell, showing the microtubular band. BB = basal body; CE = chloroplast envelope; CHL = chloroplast; ER = endoplasmic reticulum; FL = flagellum; G = golgi body; M = mitochondrion; MB = microbody; MBA = microtubular band of the flagellar apparatus; MLS = multilayered structure; N = nucleus; PM = plasma membrane (plasmalemma); PY = pyrenoid; SC = layer of diamond-shaped scales; SSTA = stroma starch; STA = starch grain appressed to the pyrenoid; THYL = thylakoid; TSC = transversely striated fibre connecting the basal bodies; VA = vacuole.

Van den Hoek *et al.*, 1995

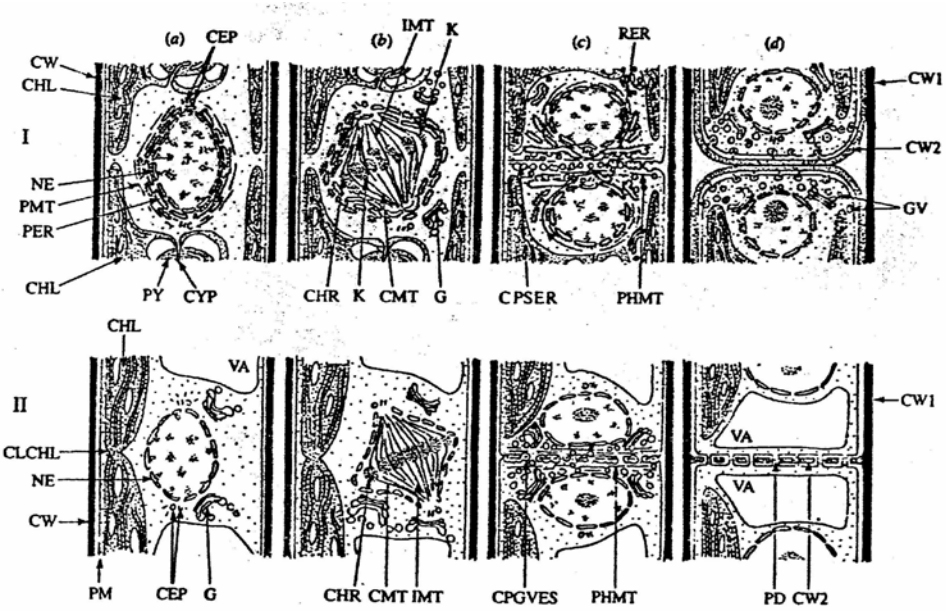


Chaetosphaeridium zoospore: a zoid of the unilateral type. Three-dimensional side view of the cell apex, showing the flagellar apparatus. BB = basal body; FL = flagellum; MBA = microtubular band (only 12 instead of the full *ca*. 60 microtubules are shown); MLS = multilayered structure; TSC = transversely striated fibre connecting the basal bodies.

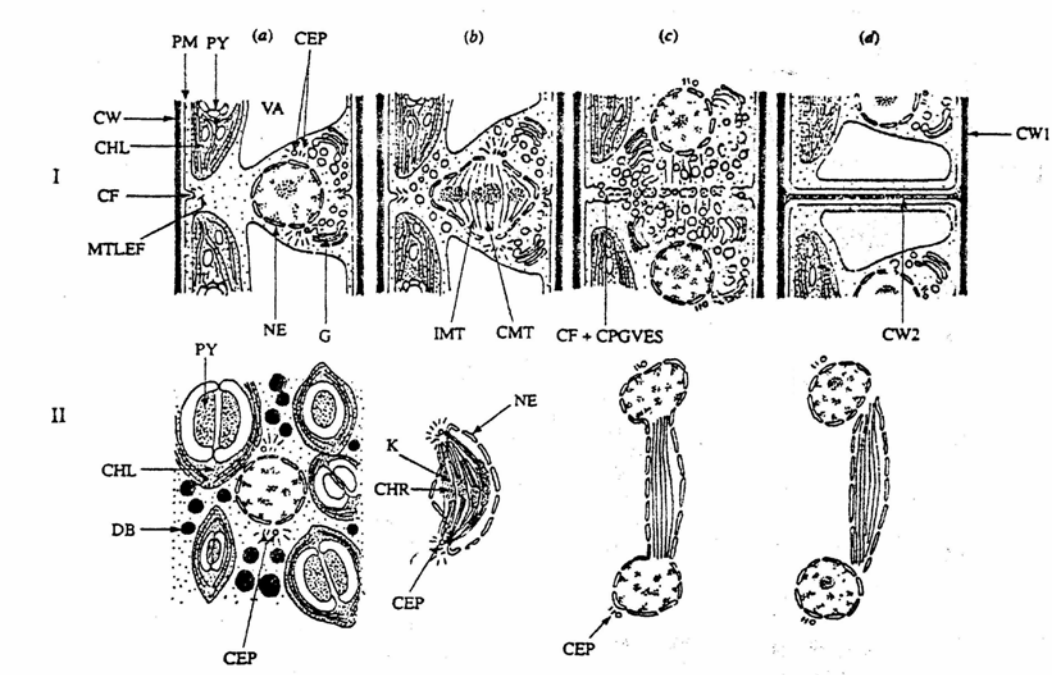
Van den Hoek *et al.*, 1995



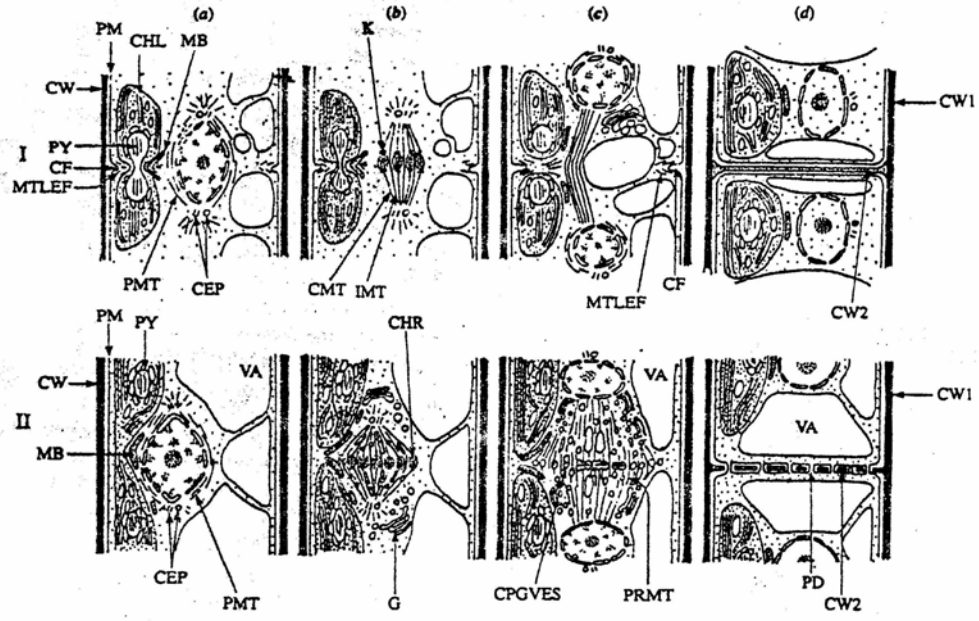
Mitosis and cytokinesis in two flagellate green algae. I. *Pyramimonas*: open mitosis with a persistent telophase spindle, cytokinesis brought about via a cleavage furrow. II. *Chlamydomonas*: closed mitosis with a collapsing (= non-persistent) telophase spindle, cytokinesis brought about by a cleavage furrow that develops within a phycoplast. See text for further explanation. Arrows indicate 90º rotation of the dividing cell within the parental cell wall. (*a*) Early prophase. (*b*) Metaphase. (*c*) Late telophase. (*d*) Early interphase. BB = basal body: BBP = basal body pair; CF = cleavage furrow; CHL = chloroplast; CHR = chromosome; CMT = chromosomal spindle microtubule; CW = wall-like envelope around cell; ER = endoplasmic reticulum; FL = flagellum; G = glogi body; IMT = interzonal spindle microtubule; K = kinetochore; N = nucleus; NE = nuclear envelope; PY = pyrenoid; PHMT = phycoplast microtubule; PM = plasma membrane (plasmalemma); RH = rhizoplast; SR = scale reservoir. Van den Hoek *et al*. 1995



Mitosis and cytokinesis in the class Chlorophyceae. I. *Cylindrocapsa*, an example of the order Chlorococcales: closed mitosis with a non-persitent telophase spindle, cytokinesis achieved by the formation of a cell plate of smooth ER vesicles lying within a phycoplast. II. *Uronema*, an exemple of the order Chaetophorales: closed mitosis with a non-persistent telophase spindle, cytokinesis brought about by a cell plate of golgi vesicles lying within a phycoplast. See text for further explanation. (*a*) Early prophase. (*b*) Metaphase. (*c*) Late telophase. (*d*) Early interphase. CEP = pair of centrioles; CHL = chloroplast; CHR = chromosome; CLCHL = cleaving chloroplast; CMT = chromosomal spindle microtubule; CPGVES = cell plate of golgi vesicles; CPSER = cell plate of smooth ER vesicles; CW = cell wall; CW1 = old cell wall; CW2 = young cell wall; CYP = cytoplasmatic channel within pyrenoid; G = golgi body; GV = golgi vesicles; IMT = interzonal spindle microtubule; K = kinetochore; NE = nuclear envelope; PD = plasmodesma; PER = perinuclear endoplasmic reticulum; PHMT = phycoplast microtubule; PM = plasma membrane (plasmalemma); PMT = perinuclear microtubule; PY = pyrenoid; RER = rough endoplasmic reticulum; VA = vacuole. Van den Hoek *et al.*, 1995

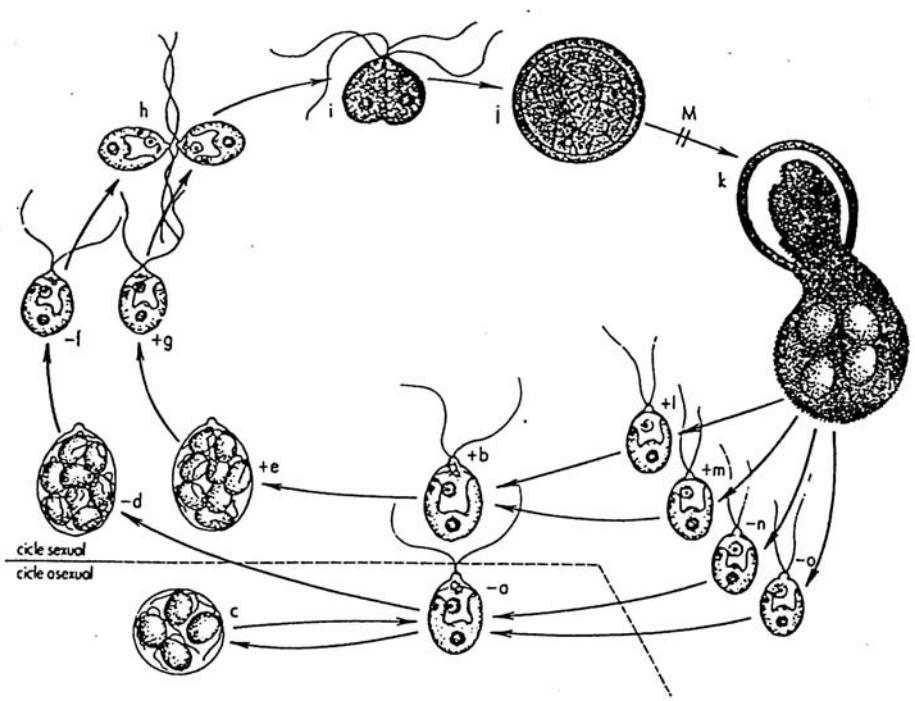


Mitosis and cytokinesis in the class Ulvophyceae (I) and the class Cladophorophyceae (II). I. *Ulothrix*, an example of a multicellular alga with uninucleate cells: closed mitosis with a persistent telophase spindle, cytokinesis brought about by a cleavage furrow, to which golgi vesicles are added, with no phycoplast. II. *Valonia*, an example with multinucleate cells: closed mitosis with a persistent telophase spindle (giving the telophase nucleus a characteristic dumbell shape), cytokinesis decoupled from mitosis. See text for further explanation. (*a*) Early prophase. (*b*) Metaphase. (*c*) Late telophase. (*d*) Early interphase. CEP = pair of centrioles; CF = cleavage furrow; CHL = chloroplast; CHR = chromosome: CMT = chromosomal spindle microtubule; CPGVES = cell plate of golgi vesicles; CW = cell wall; CW1 = old cell wall; CW2 = young cell wall; DB = dark-staining bodies; G = golgi body; IMT = interzonal spindle microtubule; K = kinetochore; MTLEF = microtubules along the leading edge of the cleavage furrow; NE = nuclear envelope; PM = plasma membrane (plasmalemma); PY = pyrenoid; VA = vacuole. Van den Hoek *et al.*, 1995



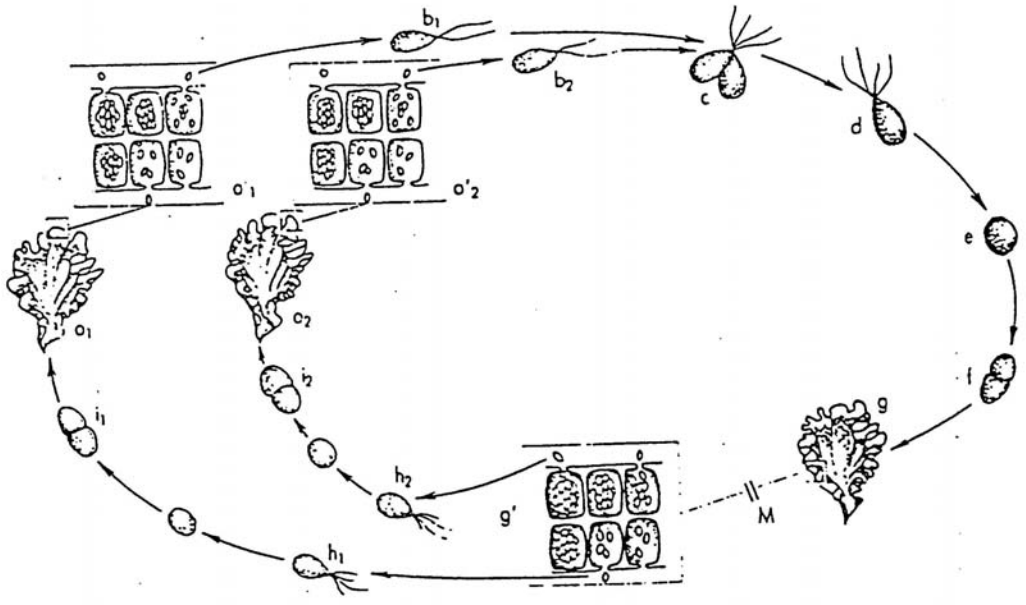
Mitosis and cytokinesis in the class Klebsormidiophyceae. I. *Klebsormidium*: open mitosis with a persistent telophase spindle, cytokinesis brought about by a cleavage furrow. II. *Coleochaete*: open mitosis with a persistent telophase spindle, cytokinesis achieved by formation of a cell plate of golgi vesicles within a phragmoplast. See text for further information. (*a*) Early prophase. (*b*) Metaphase. (*c*) Late telophase. (*d*) Early interphase. CEP = pair of centrioles; CF = cleavage furrow; CHL = chloroplast; CHR = chromosome: CMT = chromosomal spindle microtubule; CPGVES = cell plate of golgi vesicles; CW = cell wall; CW1 = old cell wall; CW2 = young cell wall; G = golgi body; IMT = interzonal spindle microtubule; K = kinetochore; MB = microbody; MTLEF = microtubules along the leading edge of the cleavage furrow; PD = plasmodesma; PM = plasma membrane (plasmalemma); PMT = prinuclear microtubule; PRMT = phragmoplast microtubule; PY = pyrenoid; VA = vacuole. Van den Hoek *et al.*, 1995

Chlamydomonas



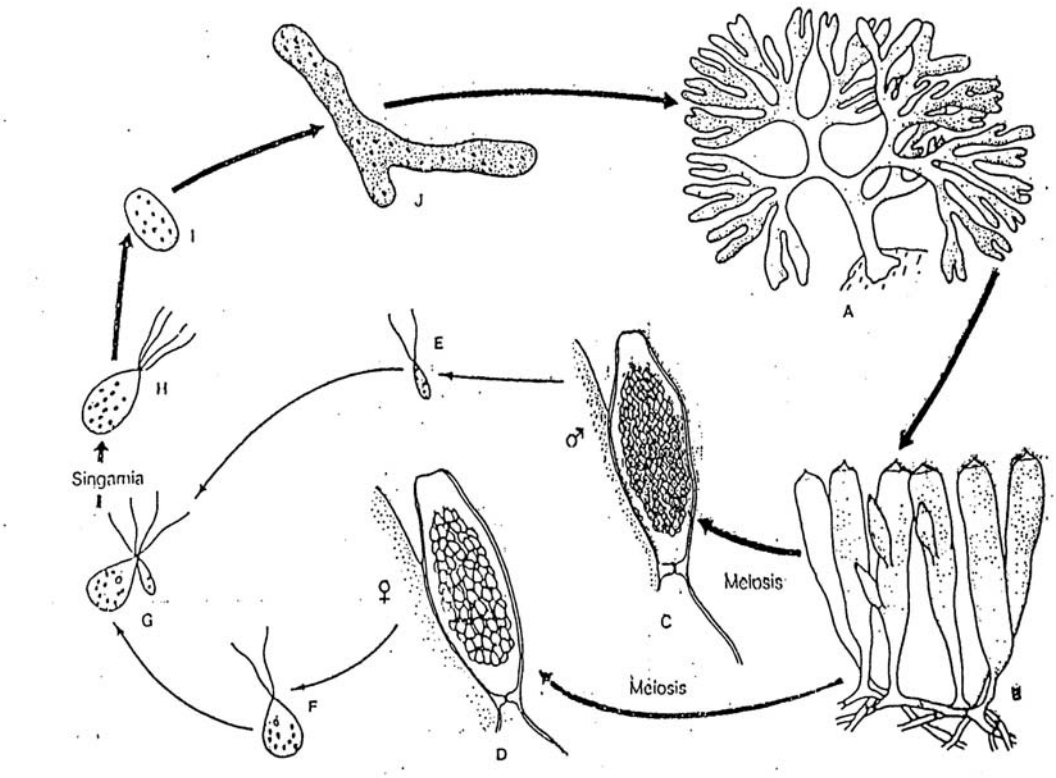
HNPC, 1984

Ulva



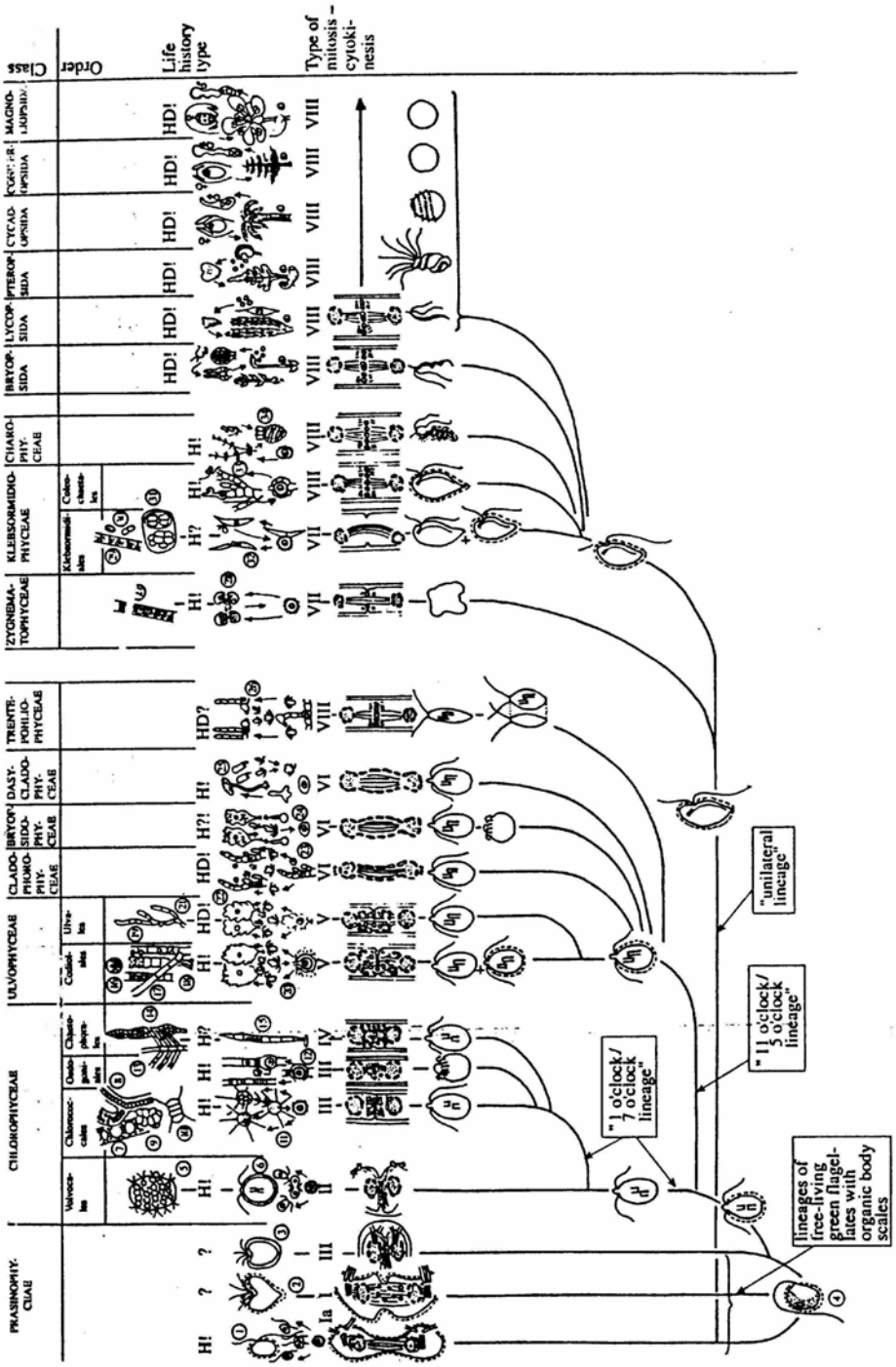
HNPC, 1984

Codium



HNPC, 1984

Prasinophyceae
Chlorophyceae
Ulvophyceae
Cladophorophyceae
Bryopsidophyceae
Dasycladophyceae
Pleurastrophyceae
Trentepholiaceae
Klebsormidiophyceae
Zygnematophyceae
Charophyceae



The phylogeny and subdivision of the Chlorophyta as put forward in the present account. 1. *Nephroselmis* (with scaly covering). 2. *Pyramimonas* (with a scaly covering). 3. *Tetraselmis* (with a theca). 4. Hypothetical *Mantoniella*- like ancestral prasinophycean green alga. 5. *Eudorina*. 6. *Chlamydomonas* (with wall-like envelope). 7. *Sphaeroplea*. 8. *Radiofilum*. 9. *Chlorosarcinopsis*. 10. *Scenedesmus*. 11. *Golenkinia*. 12. *Oedogonium*. 13. *Stigeoclonium*. 14. *Schizomeris*. 15. *Uronema*. 16. *Chlorocystris*. 17. *Ulothrix*. 18. *Urospora*. 19. *Acrosiphonia*. 20. *Monostroma*. 21. *Acrochaete*. 22. *Ulva*. 23. *Cladophora*. 24. *Udotea*. 25. *Acetabularia*. 26. *Trentepohlia*. 27. *Spirogyra*. 28. *Cosmarium*. 29, 30. *Klebsormidium*. 31. *Chlorokybus*. 32. *Raphidonema*. 33. *Coleochaete*. 34. *Chara*.

Types of life cycle:?= unknown; H! = haplontic, karyological evidence available; H?= probably haplontic, but little or no supporting karyological evidence; HD!= haplodiplontic, karyological evidence available; HD?=probably haplodiplontic, but little or no supporting karyological evidence.

Types of mitosis and cytokinesis (see also chapter 19): 1. Open mitosis with a persistent telophase spindle; cytokinesis effected by a cleavage furrow. II. Closed mitosis with a non-persistent telophase spindle; cytokinesis effected by a cleavage furrow operating within a phycoplast. III. Closed mitosis with a non-persistent telophase spindle; cytokiesis effected by formation of a cell plate of vesicles within a phycoplast. IV. Closed mitosis with a non-persistent telophase spindle; cytokinesis effected by formation of a cell plate of Golgi vesicles within a phycoplast. V. Closed mitosis with a persistent telophase spindle; cytokinesis effected by a cleavage furrow, to which Golgi vesicles are added. VI. Closed mitosis with a prominent persistent telophase spindle, which gives the telophase nucleus a characteristic dumbbell shape; mitosis not immediately followed by citokinesis. VII. Open mitosis with a prominent persistent telophase spindle; cytokinesis effected by a cleavage furrow. VIII. Open mitosis with a prominent persistent telophase spindle; cytokinesis effected by the formation of a cell plate of golgi within a phragmoplast.

Zoid architecture: the pictures of cruciate zooids indicate the rotation of the basal bodies via a small top-view diagram within the zoid. In the Ulvophyceae, Cladophorophyceae, Bryopsidophyceae, Dasycladophyceae and Trentepohliophyceae the rotation is anticlockwise (11 o'clock- 5 o'clock configuration); in the Chlorophyceae the rotation is clockwise (1 o'clock- 7 o'clock configuration). Note the scaly coverings of the zooids in the Prasinophyceae, Ulvophyceae (Codiolales), Klebsormidiophyceae and Charophyceae. Note also the hypothetical prasinophycean ancestor (bottom left), which is scaly and uniflagellate; the present day species *Mantoniella squamata* is the best available model for this ancestor).

Van den Hoek *et al.*, 1995