

Two decades ago, a Stuttgart zoo (Europe) imported a lush, bright green seaweed (*Caulerpa taxifolia*) for its aquarium, it was colorful, growing well at any condition, and provide a nice background for the aquarium fish....

In the meantime, *Caulerpa* was being bred and exposed, for years, to chemicals and ultraviolet light

Eventually a sample of it found its way to the famous Oceanographic Museum in Monaco

Fifteen years ago, while cleaning its tanks, that museum dumped the pretty green plant into the Mediterranean

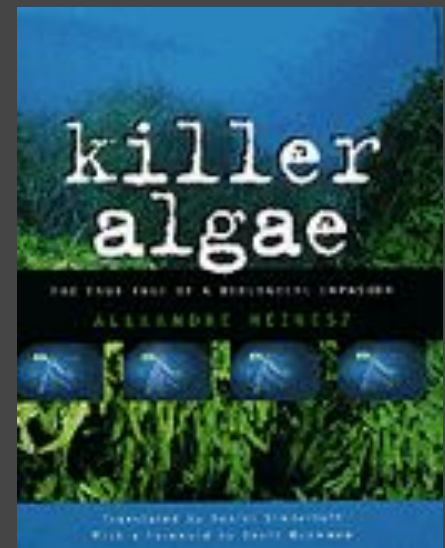
This supposedly benign little plant--that no one thought could survive the waters of the Mediterranean--now covers 10,000 acres of the coasts of France, Spain, Italy, and Croatia, and has devastated the Mediterranean ecosystem

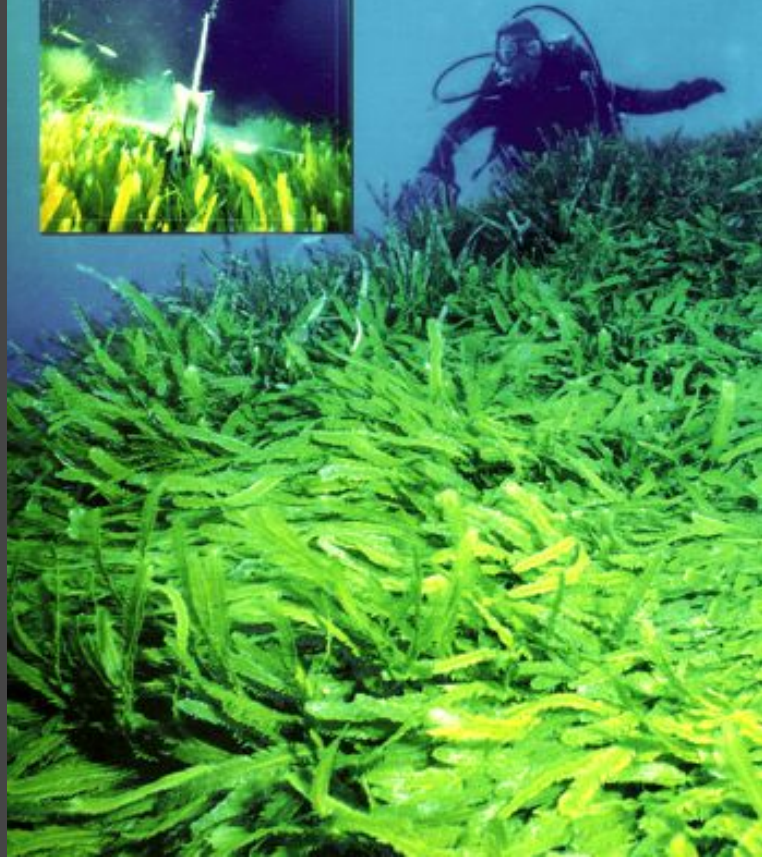
And it continues to grow, unstoppable and toxic

The alga has defeated the French Navy, thwarted scientific efforts to halt its rampage, and continues its destructive journey into the Adriatic Sea

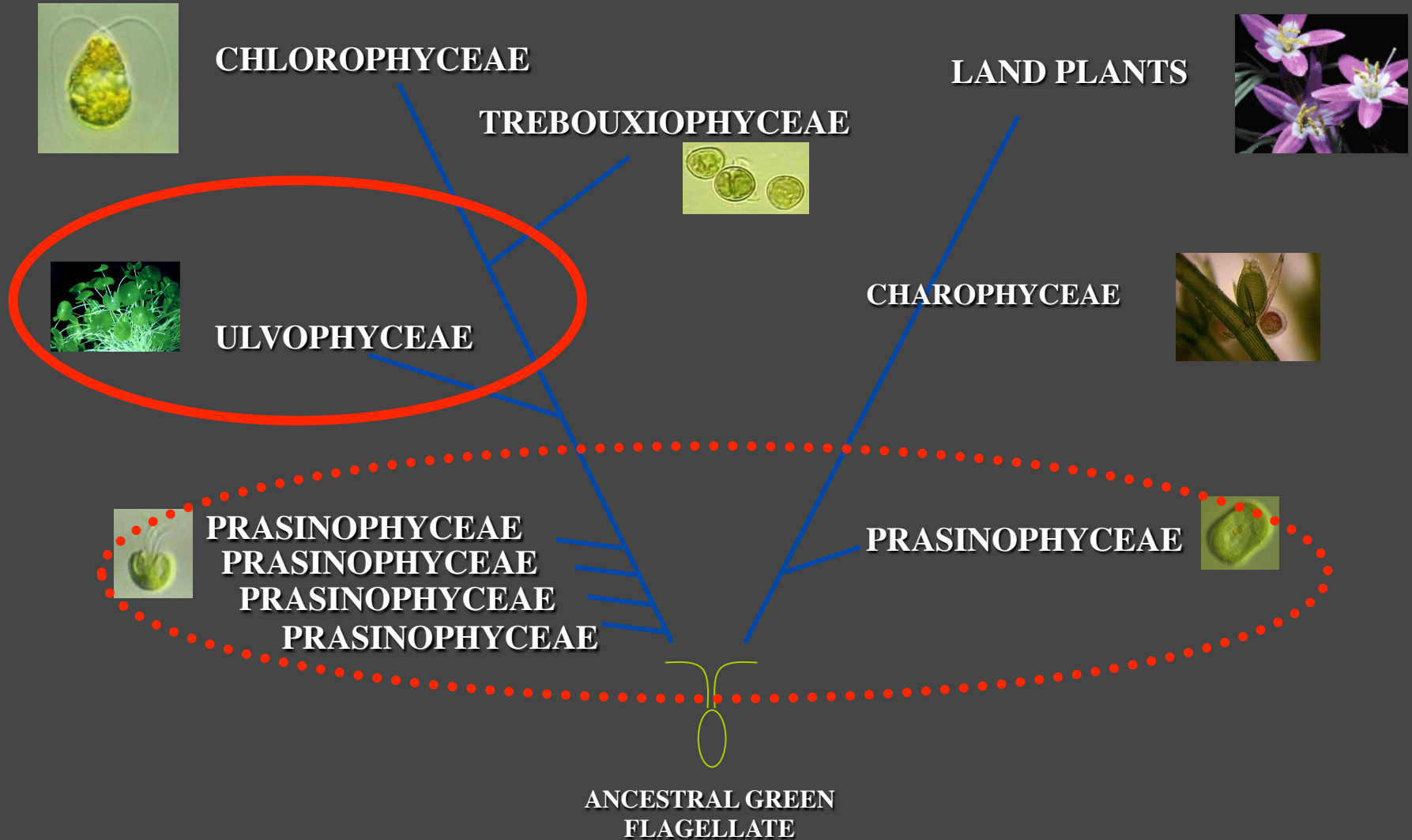
Killer Algae is the biological and political story of this invasion

Killer Algae--part detective story and part bureaucratic object lesson--is a classic case of a devastating ecological invasion and how *not* to deal with it.





ULVOPHYCEAE

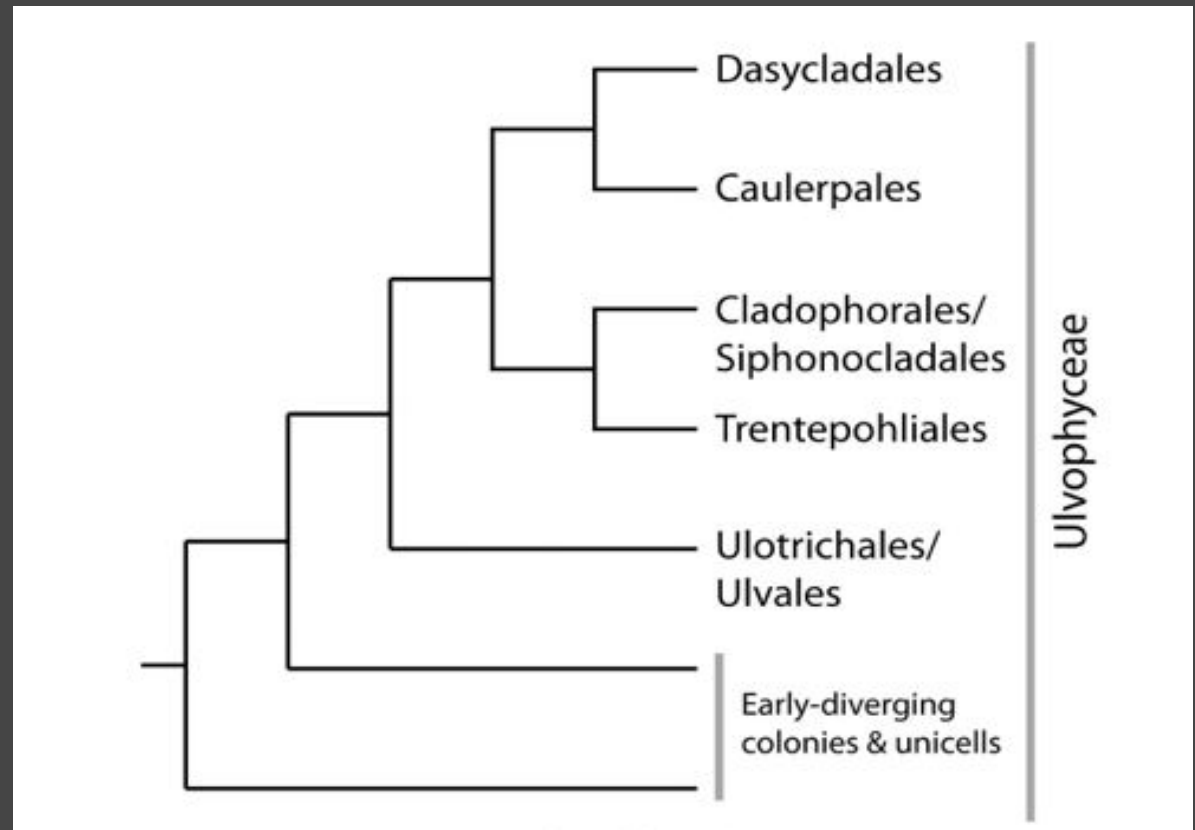


The Marine Greens!

- A. Usually marine, just like Prasinophytes!\
- B. Mostly macroalgae, few unicells or colonial thalli
- C. Unified by plesiomorphic characters: closed mitosis and furrowing cytokinesis (cfr. phragmoplast in Trentepohliales!)
- D. CCW flagellar apparatus
- E. Flagellated cells covered with scales (just like Prasinophytes!)
- F. Xanthophylls similar to Prasinophytes – Siphonoxanthine
- G. Sporic meiosis with iso- or heteromorphic alternations
- H. Zygotes generally not resistant, no akinetes! Why?
- I. Cell walls sometimes calcified and with special polysaccharides
- J. Some species are HAB, invasive and/or cultivar pests
- K. Classification 100 genera and 1100 spp.

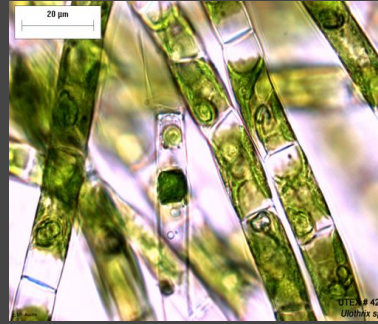
Usually classified in 6 Orders:

1. Ulotrichales/Ulvales
2. Trentepohliales
3. Cladophorales/Siphonocladales
4. Caulerpales
5. Dasycladales



1. Ulotrichales/Ulvales

- Intertidal marine algae or nearshore freshwaters
- Unbranched filaments with uninucleated (*Ulothrix*) or multinucleated cells (*Urospora*)
- Branched filaments with uninucleated (*Spongomorpha*) or multinucleated cells (*Acrosiphonia*)
- Blades (*Ulva*) or tubes (*Enteromorpha*)



Ulothrix



Urospora



Spongomorpha



Acrosiphonia



Enteromorpha

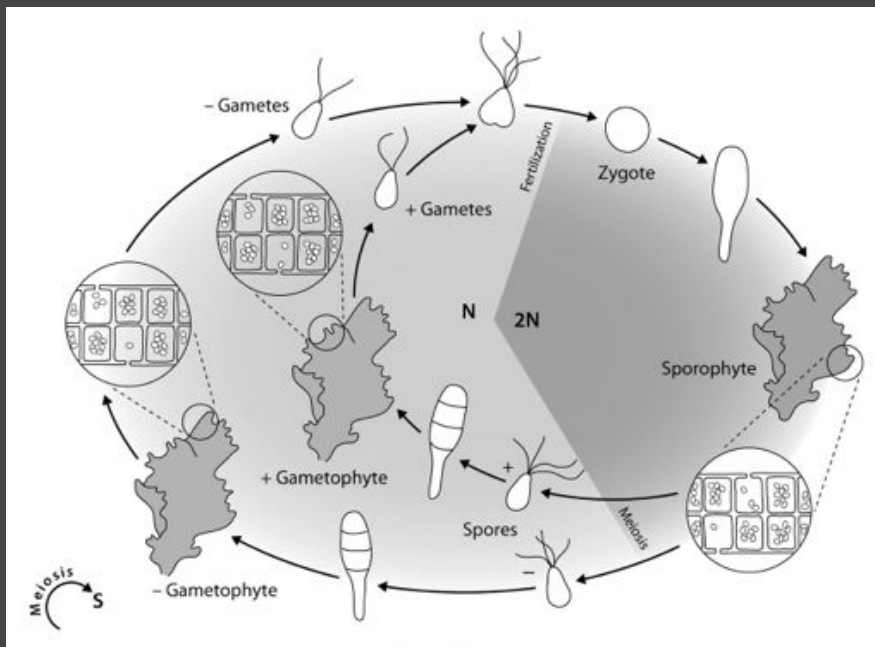


Ulva

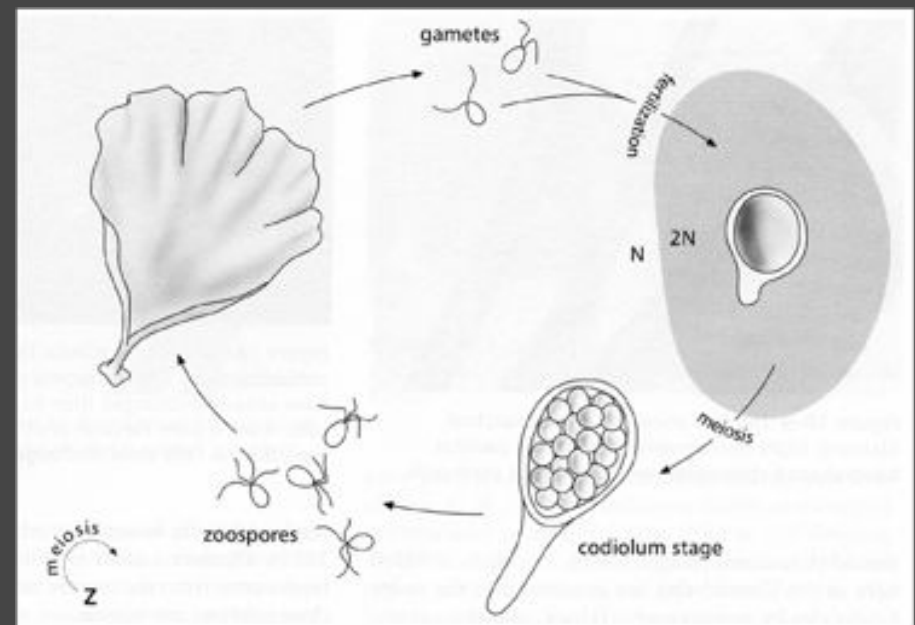
This group is divided into:

Ulvales: with an isomorphic life cycle (i.e., *Ulva*, *Enteromorpha*)

Ulotrichales: With a *Codiolum*-stage: a thick-walled, sac- or club-shaped unicellular life-history phase, attached to substrates by a stalk (*Ulothrix*, *Acrosiphonia*, *Urospora*)



Ulvales



Ulotrichales

2. Trentepohliales

- Subaerial only, ca. 100 spp
- Branched filaments, epilithic, epiphytic or endophytic
- Some acting as parasites, others as phycobionts in lichens
- Often in orange color due to the Beta-carotenes
- Uninucleated cells with many discoid pyrenoidless plastids
- Phragmoplast cytokinesis! With plasmodesmata
- Iso- and heteromorphic life cycles
- Keeled flagella



Trentepohlia growing on a tree



Trentepohlia



Phycopeltis



Cephaleuros



Stomatochroon

3. Siphonocladales/Cladophorales

- 30 genera and ca. 425 spp
- Branched or unbranched filaments
- Pseudoparenchymatous blades, nets or saccate thalli
- Few unicellular: *Spongiochrysis*
- With two characteristics: multinucleated cells and thalli compartmentalized into cells at maturity
- **Cladophorales**: thalli subdivided by cross-walls (septa) to form filaments
- **Siphonocladales**: thalli are coenocytic (lacking septa) when young but later divided by **segregative cell division** (units of cytoplasm simultaneously become surrounded by cell wall material)



Cladophorales



Cladophora



Pithophora



Chaetomorpha

Siphonocladales



Anadyomene



Valonia



Dictyosphaeria



Siphonocladus

4. Caulerpales

- Mostly marine, with 26 genera and ca. 350 spp.
- Multinucleated cells, cell walls with cellulose, OR mannans and xylans instead
- Siphonous uniaxial or multiaxial thalli, fast wound healing!
- **Uniaxial** forms are composed of a single branched siphon
- **Multiaxial** forms are dichotomously branched and robust spongy thalli; medulla with colorless filaments and cortex green and with inflated cells or **utricles** (supporting reproductive structures)
- Often calcified and growing on sandy substrates
- **Heteroplastidy** common: pigmented and unpigmented plastids
- **Holocarpy**: thalli using up all coenocyte for gamete production
- Siphonoxanthine present

Based on molecular analyses two groups or suborders are supported inside Caulerpales:

- **Brypsidineae**: Homoplastidy and non-holocarpic, *Bryopsis*, *Derbesia*, *Codium*
- **Halimedineae**: Heteroplastidy and holocarpic, *Halimeda*, *Caulerpa*, *Udotea*, *Penicillus*



Bryopsis



Derbesia

Brypsidineae



Codium

Halimedineae

Caulerpa



Penicillus



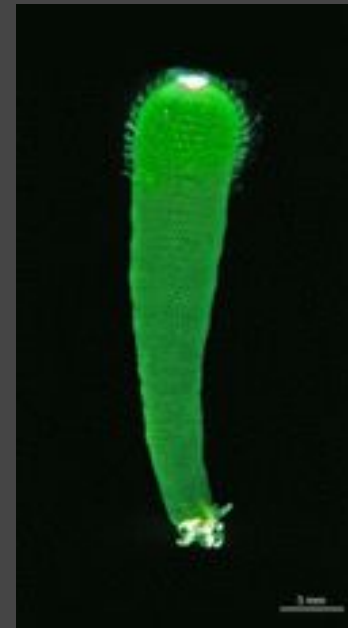
Halimeda



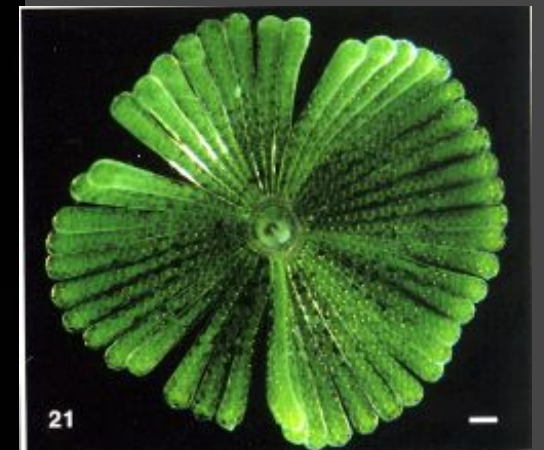
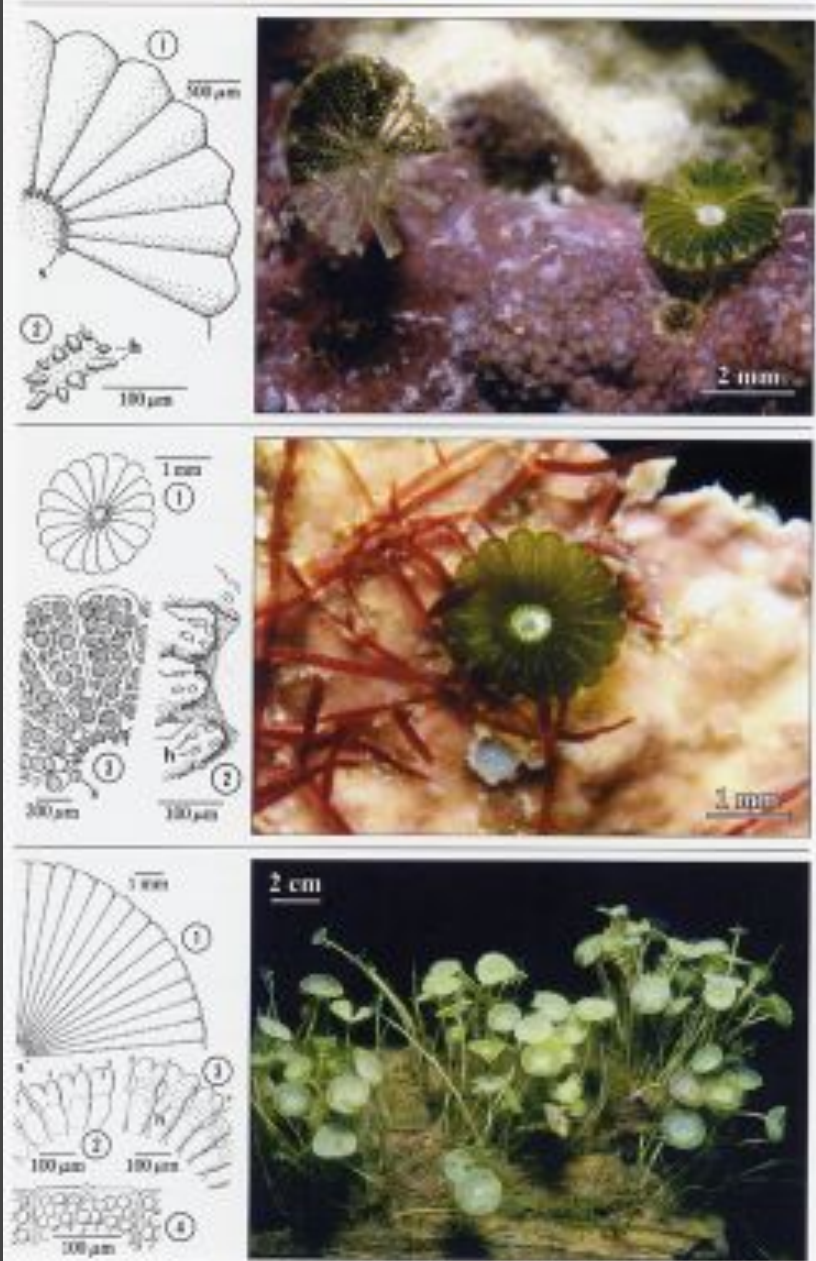
Udotea

5. Dasycladales

- Radial symmetry, many with calcified cell walls
- Siphonous thalli with a basal holdfast region (rhizoidal branches) and a diploid or polyploid nucleus, an elongated erect axis, and lateral branches in whorls
- Uninucleate until reproduction, others are multinucleated all along
- Gametes formed in cysts
- With 11 genera and 38 species



Acetabularia



Mermaid's wine glass

The Ulvophyceae continued...

Codium fragile and *Caulerpa taxifolia*

invasions: *C. fragile* USA east coast & Europe

C. taxifolia Mediterranean and CA!

(n.b. ballast water & aquaria & global ecology)

