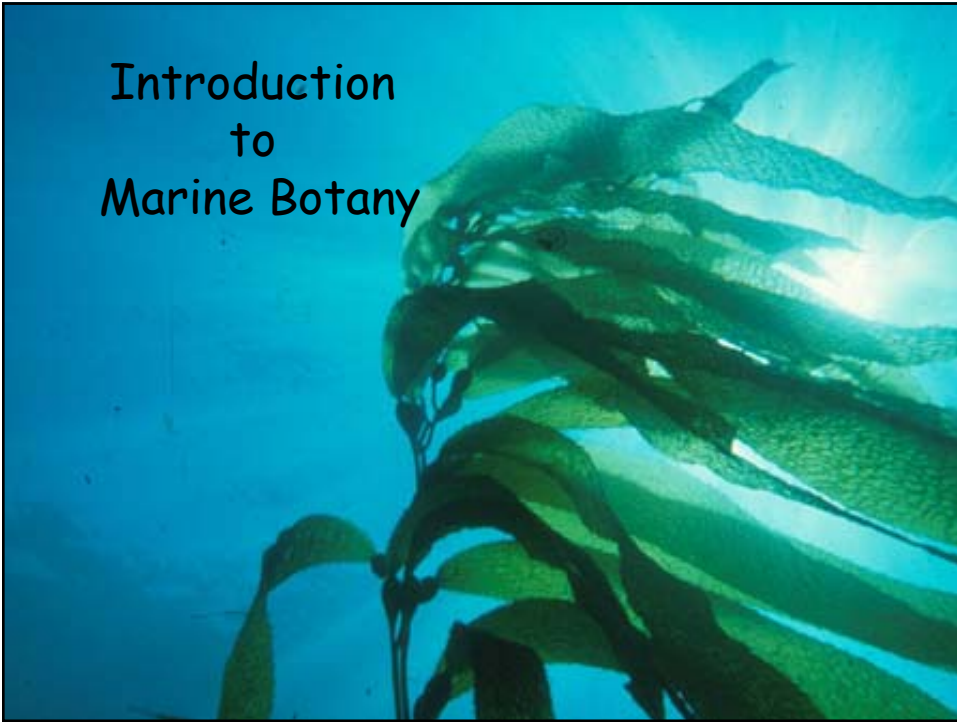


# Introduction to Marine Botany



- Botany = study of plants
- Phycology = study of algae (Latin)
- Algology = less correct (close to the study of pain) (Greek)

This course: "Marine Botany" = mostly macroalgae, a little about cyanobacteria, phytoplankton, seagrasses, a salt marsh plants, and (maybe mangroves / dune plants)

FYI →

alga (singular)  
algae (plural)  
algal (adj.)  
"algaes" (wrong!)

## 5 Kingdom system:

Animalia

Plantae = angiosperms, gymnosperms, bryophytes (mosses, liverworts, hornworts)

Protista = most diverse group, eukaryotic organisms that are not Animalia, Plantae, or Fungi (protista are now thought to be split into many kingdoms)

Monera = prokaryotic, bacteria and things like bacteria (cyanobacteria), no membrane-enclosed nucleus or organelles

Fungi

2

## 5 Kingdom system: where do marine "plants" fit in?

Animals

Plants = seagrasses, mangroves, marsh and dune plants  
"algae"

Protista = seaweeds (macrophytes)  
phytoplankton (microphytes)

Monera = cyanobacteria

Fungi

3

### Three main divisions of seaweeds:



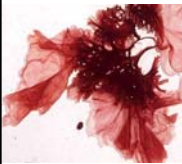
#### Chlorophyta:

~16,000 species; 1,300 are marine (most are fH<sub>2</sub>O)



#### Heterokontophyta:

~1,500 species; most are marine



#### Rhodophyta:

~6,000 species; 5,800 marine

4

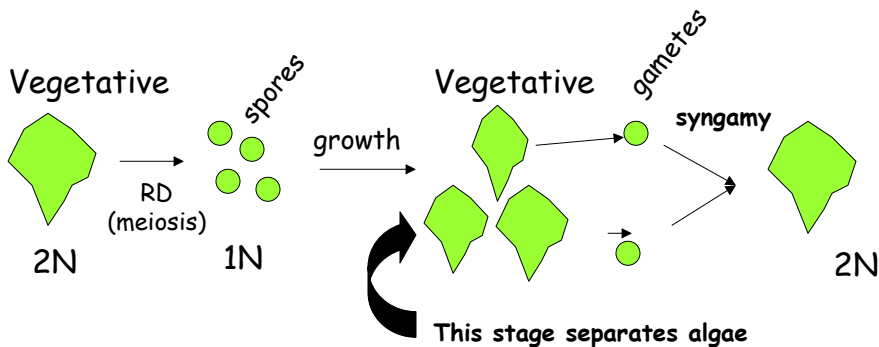
### What are algae?

- polyphyletic group = different ancestors, different evolutionary histories
- *Current thought:* each of seaweed divisions are monophyletic, but they evolved independently of each other
- algae are polyphyletic at the level of KINGDOM: group includes prokaryotes (cyanobacteria) AND eukaryotes (green, brown, red algae)
- green, red, and brown algae are now thought to be in different kingdoms (some biologists place greens in Plantae)
- For this class we will treat greens, browns, and reds as divisions (consistent with books)

5

## Separated from animals

- Algae produce spores (asexual reproductive cells) as well as gametes (sexual cells).
- Animals only produce gametes.



6

### Defining characteristics of algae:

Photosynthesis (photoautotrophic, usually), using Chl a as primary pigment

BUT: Limited cellular differentiation compared to terrestrial plants

- ✓ no "real" vascular system
- ✓ sex organs unicellular or if multicellular -> "naked"
- ✓ "naked" reproductive structures (no sterile layer of cells surrounding sex organs)
- ✓ In some cases: all cells capable of reproduction

(Also, MUCH greater diversity of photosynthetic pigments and life histories than plants)

7

Brief history of photosynthetic organisms on earth...

3.45 bya = Cyanobacteria appear and introduce photosynthesis

1.5 bya = first Eukaryotes appeared

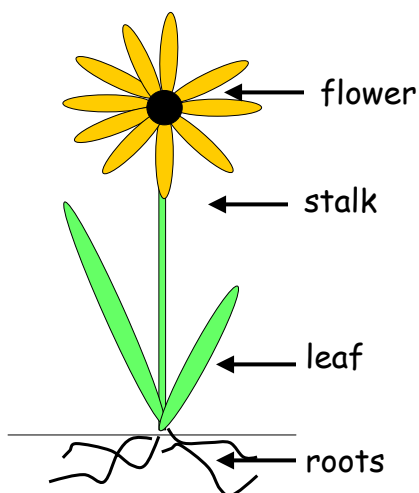
400-500 mya = plants on land

All terrestrial plants are derived from a single division of algae (Charophyceae - the progenitor); seaweeds include three divisions (**Chlorophyta**, **Heterokontophyta**, **Rhodophyta**)

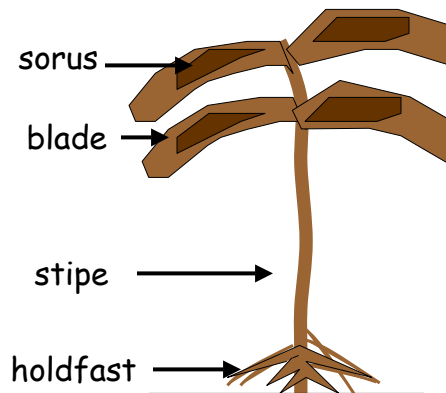
Seagrasses = terrestrial plants that went back to the sea... (>200,000 terrestrial angiosperms, only ~50 marine).

8

**A Vascular plant**

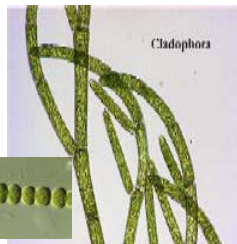
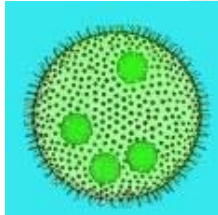


**An Alga**



9

Algae show tremendous diversity of form, habitat, and lifestyle



unicells, colonies, filaments, foliose....to more complex.....

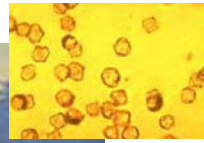
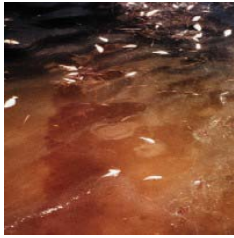
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Found in all bodies of water (freshwater, marine intertidal and subtidal...) as well as terrestrial systems with enough moisture

11

### Free-living and unattached



Red tides = dinoflagellates like *Lingulodinium polyedrum* ("planktonic")



Unattached macroalgae? Rhodoliths  
("benthic" = bottom dwelling)

12

### Free-living and attached to the substrate



*Postelsia palmaeformis*  
"saxicolous", or "saxiphytic"



*Caulerpa taxifolia*  
"psammophytic"

13



## Epiphytic



*Smithora naiadum* on  
*Phyllospadix torreyi*

## Parasitic



*Trentepohlia* on  
Monterey Cypress

14

## Symbiotic and Endosymbiotic

Lichen = close association  
of an alga and a fungus



Marine: Zooxanthellae in corals, anemonies,  
nudibranchs, flatworms...



Dinoflagellates and Radiolarians



fH2O tool: Zoochlorellae in hydras, sponges, etc.

15



Taxonomy/systematics constantly under revision

- depending on who you ask, between 50,000 and 10 million different algal spp!

How to define species???

- Biological species concept?

- Morphology?

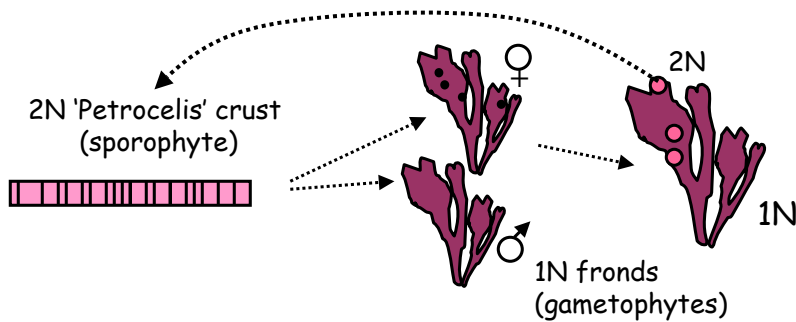
- Genetics?

16



17

*Mastocarpus papillatus*



18

History of algal classification:

- First, morphology...
- Then ultrastructure (e.g. plastids, cell walls)...
- Now molecular genetic data.
  - Usually sequence data from ribosomal RNA genes
- Often conflict among methods
- Bottom line → taxonomy in constant flux

19

## Algal taxonomy

Hierarchical system of classification...

<u>Level:</u>	<u>suffix:</u>
Kingdom	
Phylum/Division	-phyta
Class	-phyceae
Order	-ales
Family	-aceae
Genus	
Species	



- King Phillip Came Over For Good Spaghetti
- Keep Dishes Clean Or Family Gets Sick

20

## Algal taxonomy

Hierarchical system of classification...

<u>Level:</u>	<u>suffix:</u>	<u>example:</u>
Kingdom		Protista
Phylum/Division	-phyta	Chlorophyta
Class	-phyceae	Chlorophyceae
Order	-ales	Ulotrichales
Family	-aceae	Ulvaceae
Genus		<i>Ulva</i>
Species		<i>fenestrata</i>



21

- nomenclature acknowledges the first and last person to describe the species

for example: Linnaeus called this *Fucus pyriferus*, later renamed *Macrocystis pyrifera* by Carl Adardh, so...



*Macrocystis pyrifera* (L.) C. Adardh

22

1753, Linnaeus divided all life into two Phyla =  
*Plants* and *Animals*

Within the plants, he recognized

- *Cryptogams* - hidden gametes
- *Thallogams* - unspecialized gametes ... the algae

Only three genera originally recognized:

*Fucus*

*Ulva*

*Conferva*



23

Division	% marine	~# species	<u># in MAC</u>
Cyanophyta (blue-green algae)	8	2,000	
Rhodophyta (red algae)	98	6,000	459
Chlorophyta (green algae)	13	16,000	72
Heterokontophyta (brown algae)	99	1,500	137
Bacillariophyceae (diatoms)	50	10,000	
Dinophyta (dinoflagellates)	90	2,000	
<i>Bryophyta</i>			
Mosses, liverworts	0	25,000	
<i>Vascular plants</i>			
Ferns, horsetail, club moss	0.1	13,018	
Gymnosperms	0	722	
Angiosperms	0.09	285,000	

24

### Algal characteristics for distinguishing divisions:

1. Pigments
2. Storage products
3. Cellular/plastid structure
4. Motility (e.g. +/- flagella)
5. Life history

We will visit each of these in detail later.....

25

