Dominant Types of Plankton

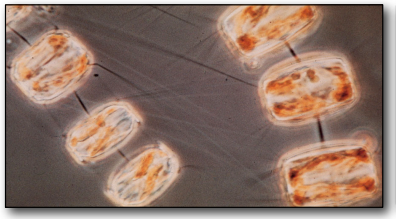
- Phytoplankton
  - Diatoms – dominant in neritic & upwelling zones
  - Microflagellates – dominant in oceanic zone
  - Dinoflagellates – dominant in transitional situations
- Zooplankton
  - Protozoa (single-celled)
  - Crustaceans
  - Gelatinous
  - Larvae

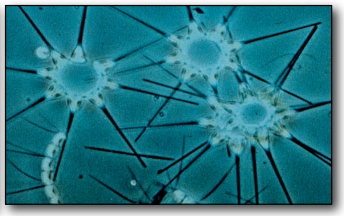
Phytoplankton Size

- Each size has advantages & disadvantages
  - Small cells
    - Grow more slowly
    - But have more surface area
      - Sink more slowly
      - Take up nutrients more readily
    - Being small can be an advantage
      - Where there is little mixing or upwelling
    - Some small cells “fix” nitrogen gas into nutrients
  - Large cells
    - Grow more rapidly
    - But sink more rapidly
    - Less able to take up nutrients when scarce

Diatoms

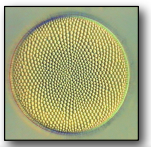
- Mostly large with heavy silica shell
  - More vulnerable to sinking
    - Use spines & chains to increase surface area & resistance like a parachute
    - Some species increase flotation
      - Take up light ions
      - Store fats & oils

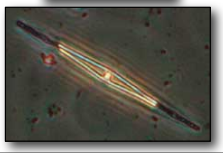




Diatoms

- Rapid growth rate when light and nutrients are available
  - Advantage when mixing & upwelling provide nutrients
  - Out-compete other phytoplankton in neritic & upwelling zones
  - Two types
    - Centric (circular)
      - Coscinodiscus sp., a solitary centric diatom http://www.biol.tsukuba.ac.jp/ino/st/baci/coscino.gif
    - Pennate (elliptical)
      - Amphipleura sp.. a solitary pennate diatom www.serc.si.edu/labs/phytoplankton/guide/addtl_collections/Belize%202/amphipell.jsp

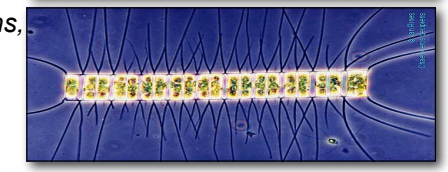




Diatoms

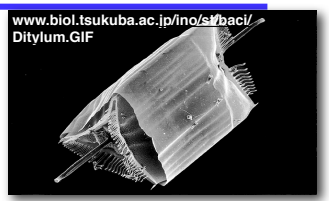
- Sink out rapidly under unfavorable conditions
  - Mixing & upwelling greatly reduced
  - Nutrients exhausted
  - Chain & spined forms persist longer
    - *Skeletonema costatum*, a chain-forming centric diatom

    - *Chaetoceros decipiens*, a chain-forming spiny centric diatom

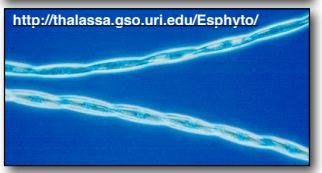


Variety of Diatoms

- *Ditylum brightwellii*, a (usually) solitary centric diatom



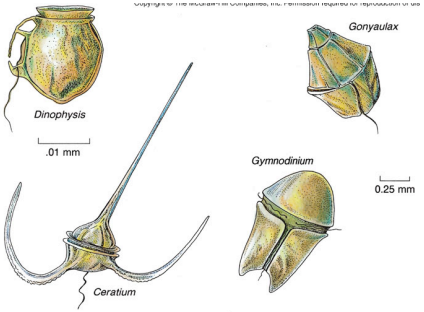
- *Pseudo-nitzschia fraudulenta*, a chain-forming pennate diatom suspected to be toxic



- *Thalassionema nitzschioides*, a chain-forming pennate diatom

Dinoflagellates

- Cellulose outer skeleton in most species
- Swim using two flagella
  - Able to hold position at bottom of euphotic zone where nutrients are more abundant
  - Able to migrate up in daytime for light & down at night for nutrients
  - Moderate growth rate when light & nutrients are decreasing



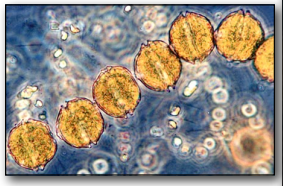
Variety of Dinoflagellates

- Spined, spineless
  - *Ceratium fusus*, a solitary spined dinoflagellate →

- Outer cellulose skeleton sometimes absent (naked)
- Bioluminescence
  - *Noctiluca scintillans*, a solitary naked bioluminescent dinoflagellate →

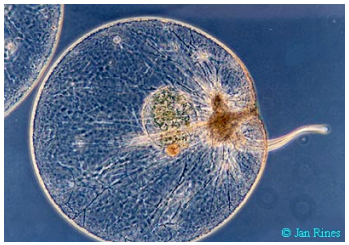
http://thalassa.gso.uri.edu/Esphyto/

- Chain-forming
- Toxic (“red tides”)
  - *Alexandrium catenallum*, a chain-forming toxic dinoflagellate →



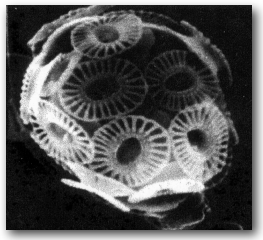
"Red Tide" Dinoflagellates

- *Noctiluca scintillans*, an anomalous heterotrophic "red-tide"-forming non-toxic dinoflagellate
  - "Tomato-soup" colored clouds at surface
  - Most common & visible "red tide" in Puget Sound
  - Occurs in stratified water in mid- to late summer

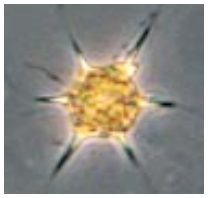


Microflagellates

- Variety of taxonomic groups
- Distinguished by
  - Very small size (micro-)
  - Ability to swim (-flagellates)
    - Another advantage where there is little mixing or upwelling
    - Avoid sinking
    - Maintain depth at which both light & nutrients are available
- May have outer skeleton
- Some are toxic ("red tides")



Emiliani huxleyi, a occolithophorid



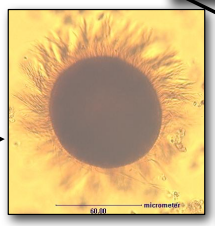
Distephanus speculum, a silicoflagellate

Zooplankton: Protozoa

- Single-celled animals "Microzooplankton"
- Ciliates
  - Filter feeders using cilia
  - Outer shell of cemented particles
- Foraminifera
  - Ameboid feeders
  - Outer shell of calcium carbonate
- Radiolaria
  - Ameboid feeders
  - Outer shell of silica

Ciliate Protozoa

- *Strombidium conicum* Diane Stoecker http://life.bio.sunysb.edu/marinebio/plankton.html
- Tintinnid ciliate http://www.sdmesa.sdccd.net/ilc/biology/plankton/index.htm
- *Mesodinium rubrum* © Karl Embleton http://192.171.163.165/pil/plankton_image_database_homepage.htm



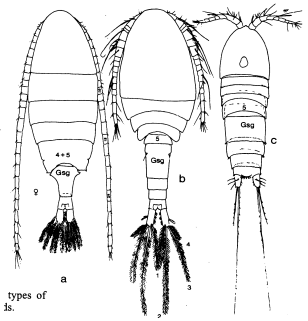
Zooplankton: Protozoa

- Foraminifera
- Radiolaria

www.imagequest3d.com/pages/shop/Posters/plankton.htm

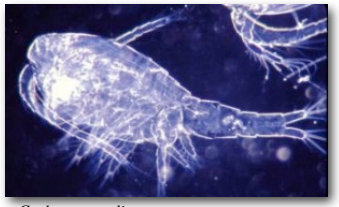
Crustaceans

- Three major characteristics
  - Outer skeleton of calcium carbonate & chitin
  - Segmented bodies
  - Multiple jointed appendages
- Two major groupings in zooplankton
  - Copepods
  - "Krill"
    - Euphausiids
    - Amphipods
    - Mysids



Variety of Copepods

Paracalanus parvus
http://www.dnr.state.md.us/bay/monitoring/zoop/animal.html,



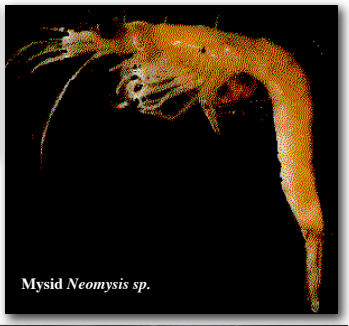
Cyclops vernalis
http://www.sams.ac.uk/dml/projects/zooplank/

Eurytemora affinis http://life.bio.sunysb.edu/marinebio/plankton.html

Paraeuchaeta elongata

Krill: Euphausiids & Mysids

Euphausiid *Meganycthiphanes norvegica*
http://life.bio.sunysb.edu/marinebio/plankton.html



Mysid *Neomysis sp.*

Krill: Amphipods & Shrimp



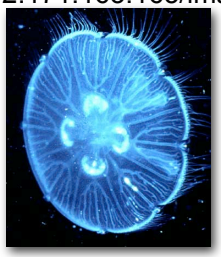

Hyperiid amphipod (carnivore)
Pandalid juvenile (carnivore)
Norman T. Nicoll http://192.171.163.165/image_lib.htm

Gelatinous zooplankton

- Cnidarian
  - Drifting ambush predators with stinging tentacles
  - Medusae ("jellyfish")
  - Siphonophores—complex colonies, no polyp stage
- Pteropods = winged foot ("sea slugs")
  - Suspension feeders with mucus webs
- Ctenophores ("comb jellies, sea gooseberries")
  - Drifting ambush predators with non-stinging tentacles
- Chaetognaths = spiny jaws ("arrow worms")
  - Attack predators on copepods, fish larvae

Cnidarian Medusa

- Same phylum as coral
- Medusae alternate generations with the polyp life-cycle stage
  - Norman T. Nicoll http://192.171.163.165/image_lib.htm

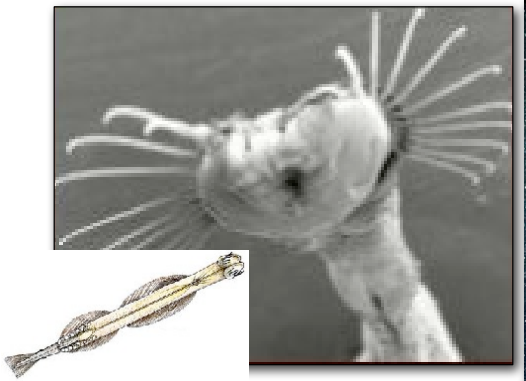



Gelatinous Zooplankton

Hula skirt siphonophore *Physophora hydrostatica*
www.mbayaq.org/efc/living_species/default.asp?inhab=182

Pteropod mollusk *Clione limacina* (herbivore)
Norman T. Nicoll http://192.171.163.165/image_lib.htm

Gelatinous zooplankton



Chaetognath (Active predator) *Sagitta elegans*
www.lifesci.ucsb.edu/~haddock/plankton/others.html
www.jochemnet.de/fiu/OCB3043_24.html

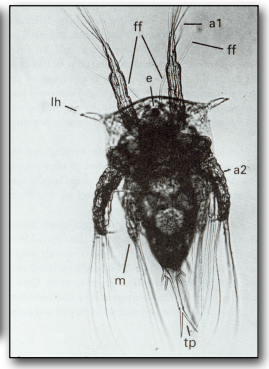
Ctenophore (Ambush predator) *Pleurobrachei pileus*
Norman T. Nicoll http://192.171.163.165/image_lib.htm

Larvae of non-planktonic adults

- Mollusks (snail)
- Annelids (segmented worms)
- Crustaceans (crab)
- Echinoderms
  - Sea urchin
  - Sea star
- Chordates
  - Possess a notochord, precursor to spinal cord
  - Gelatinous larvaceans & salps
  - Vertebrates (fish)

Nauplius Crustacean Larvae

Copepod
http://www.sams.ac.uk/dml/projects/zooplank/

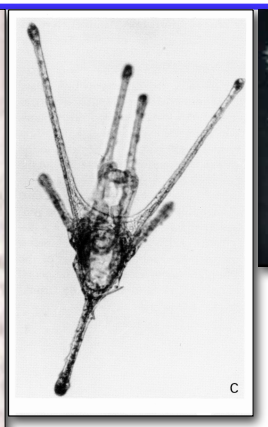


Barnacle

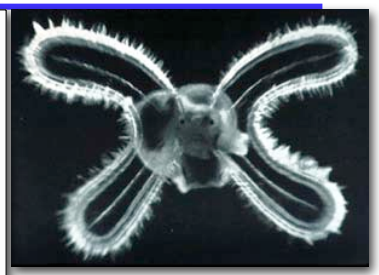
Crab

Invertebrate Larvae

Annelid Worm
http://life.bio.sunysb.edu/marinebio/plankton.html



Echinoderm (sea urchin)

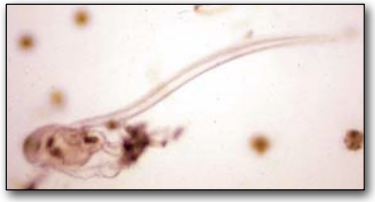


Mollusk veliger (snail)
http://life.bio.sunysb.edu/marinebio/plankton.html

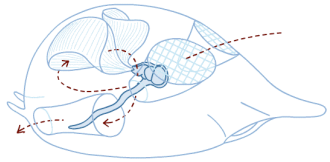
Chordates (Vertebrates)

- Non-vertebrate chordates
  - Salps & Larvaceans
    - Both filterers
- Vertebrates

Fish larva (Vertebrate) *Clupea sp*. (herring)
Norman T. Nicoll http://192.171.163.165/image_lib.htm



Larvacean *Oikopleura dioica* (Urochordate)
http://life.bio.sunysb.edu/marinebio/plankton.html



www.microscopy-uk.org.uk/mag/artjan01/oiko.html