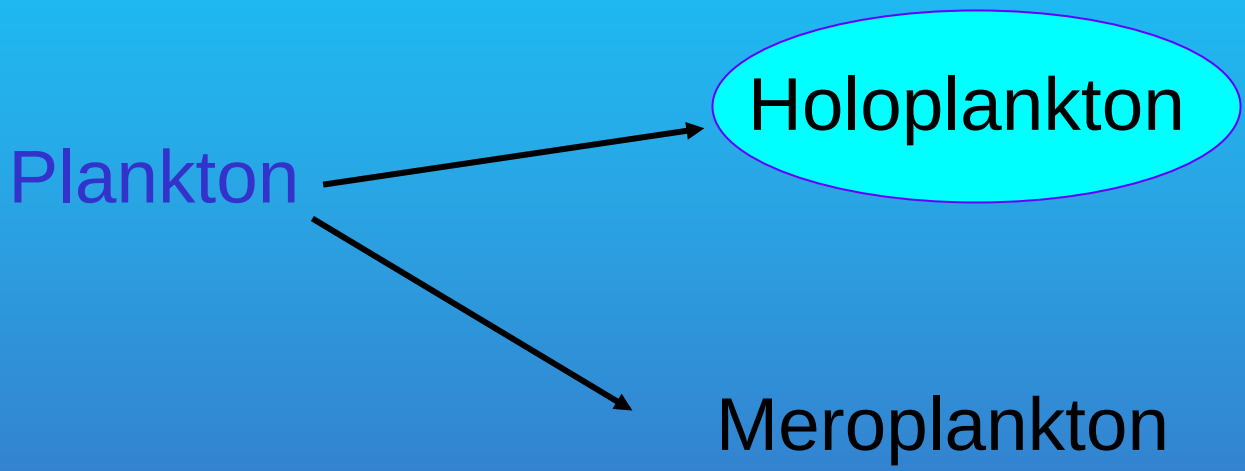
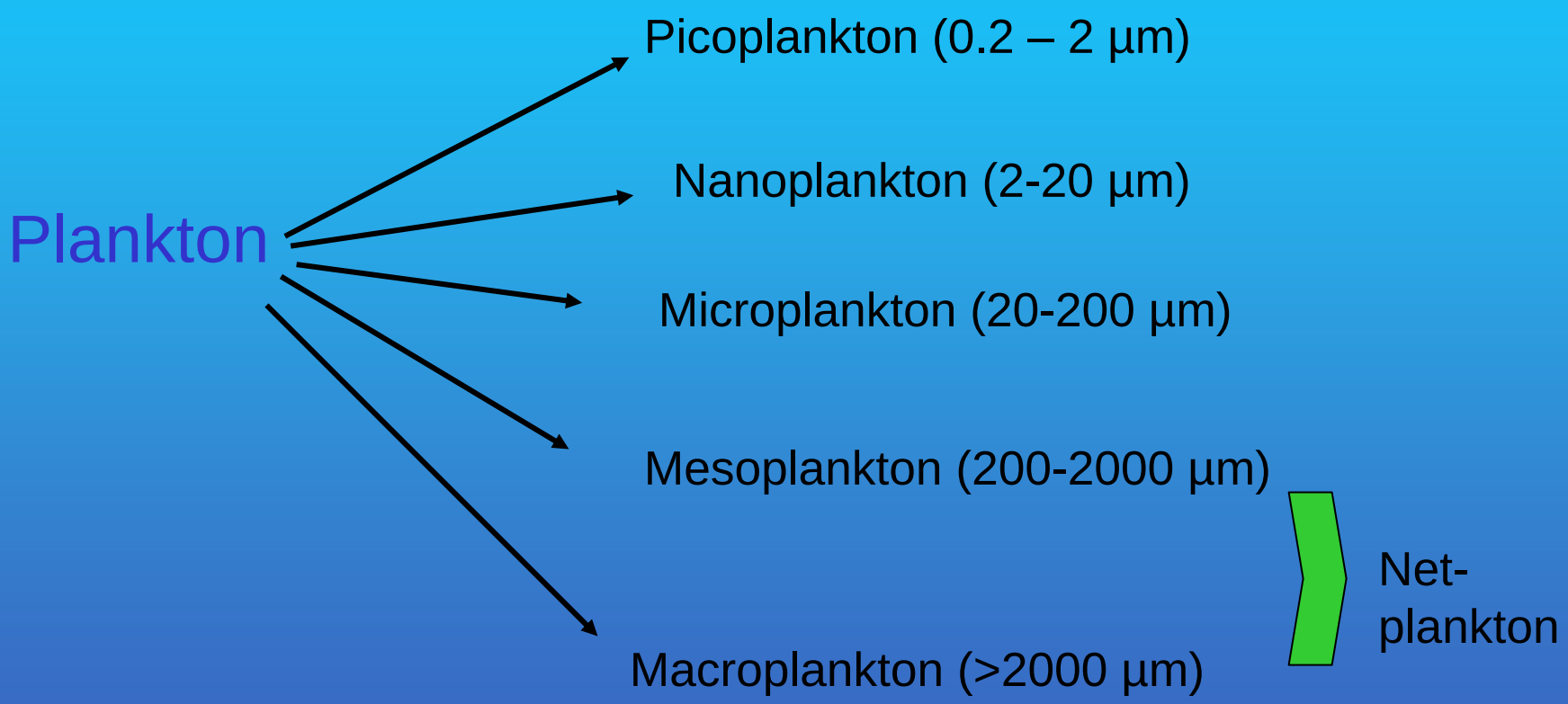
Zooplankton

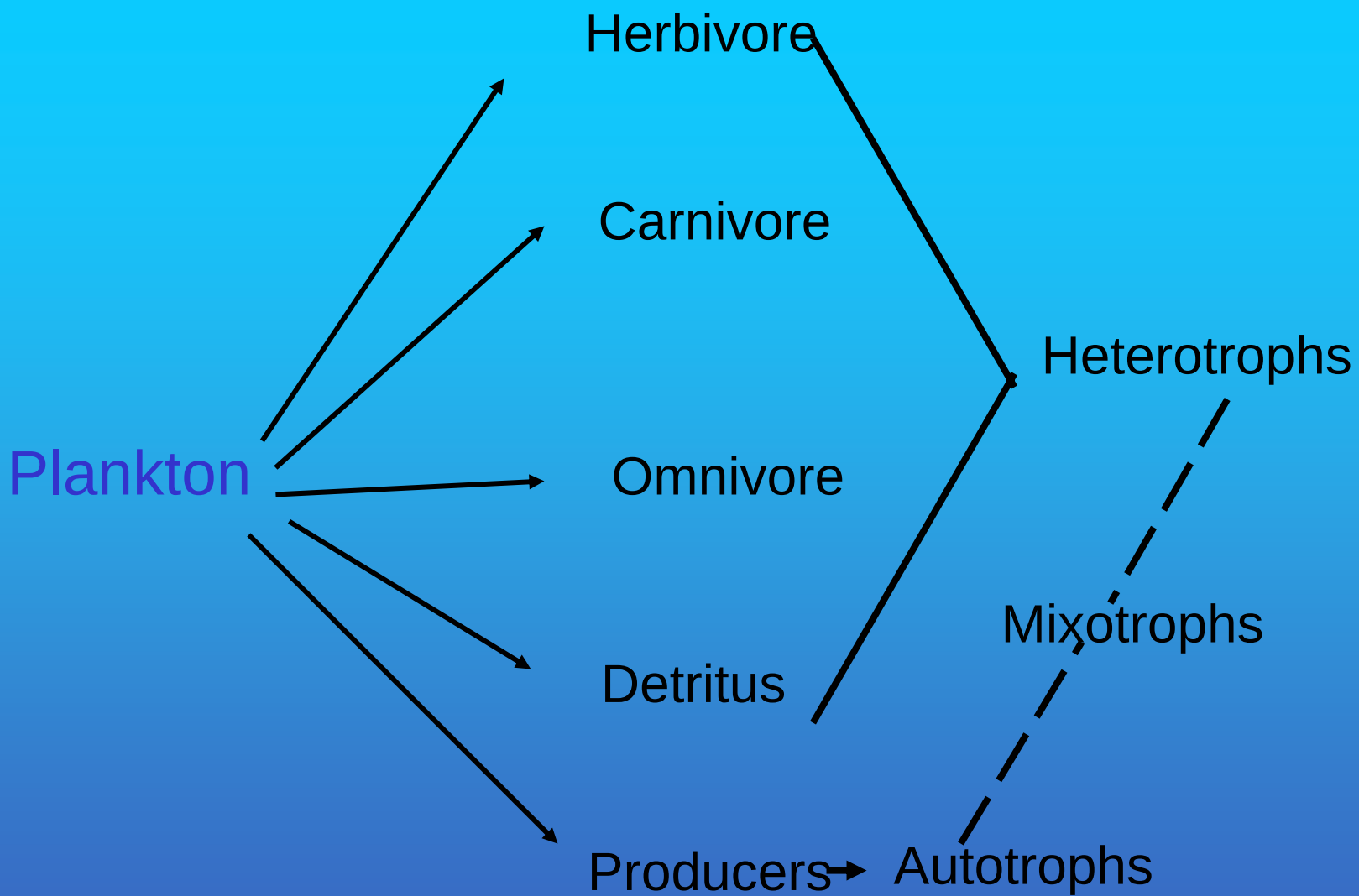
Fall 2006

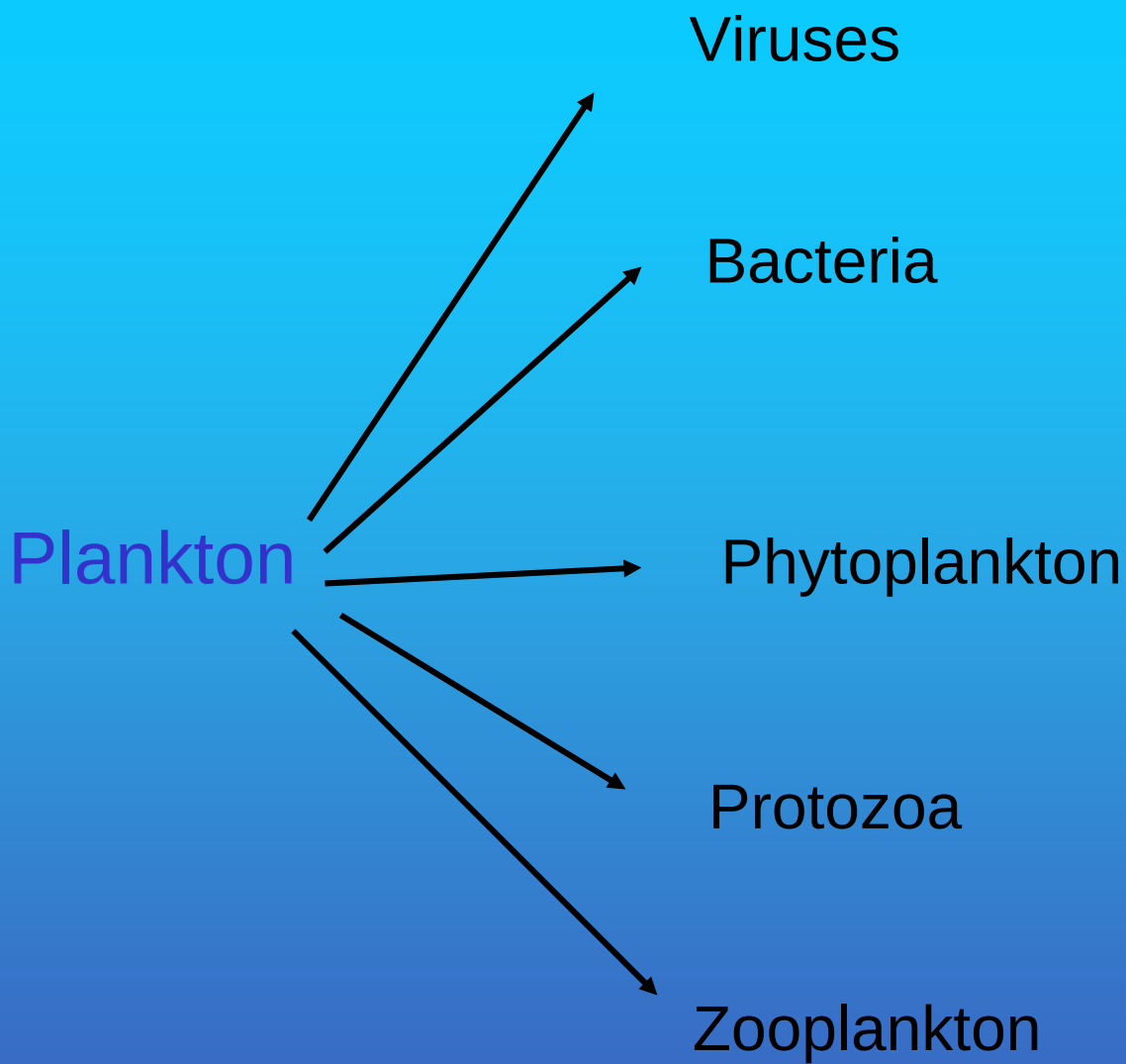
Plankton Classification

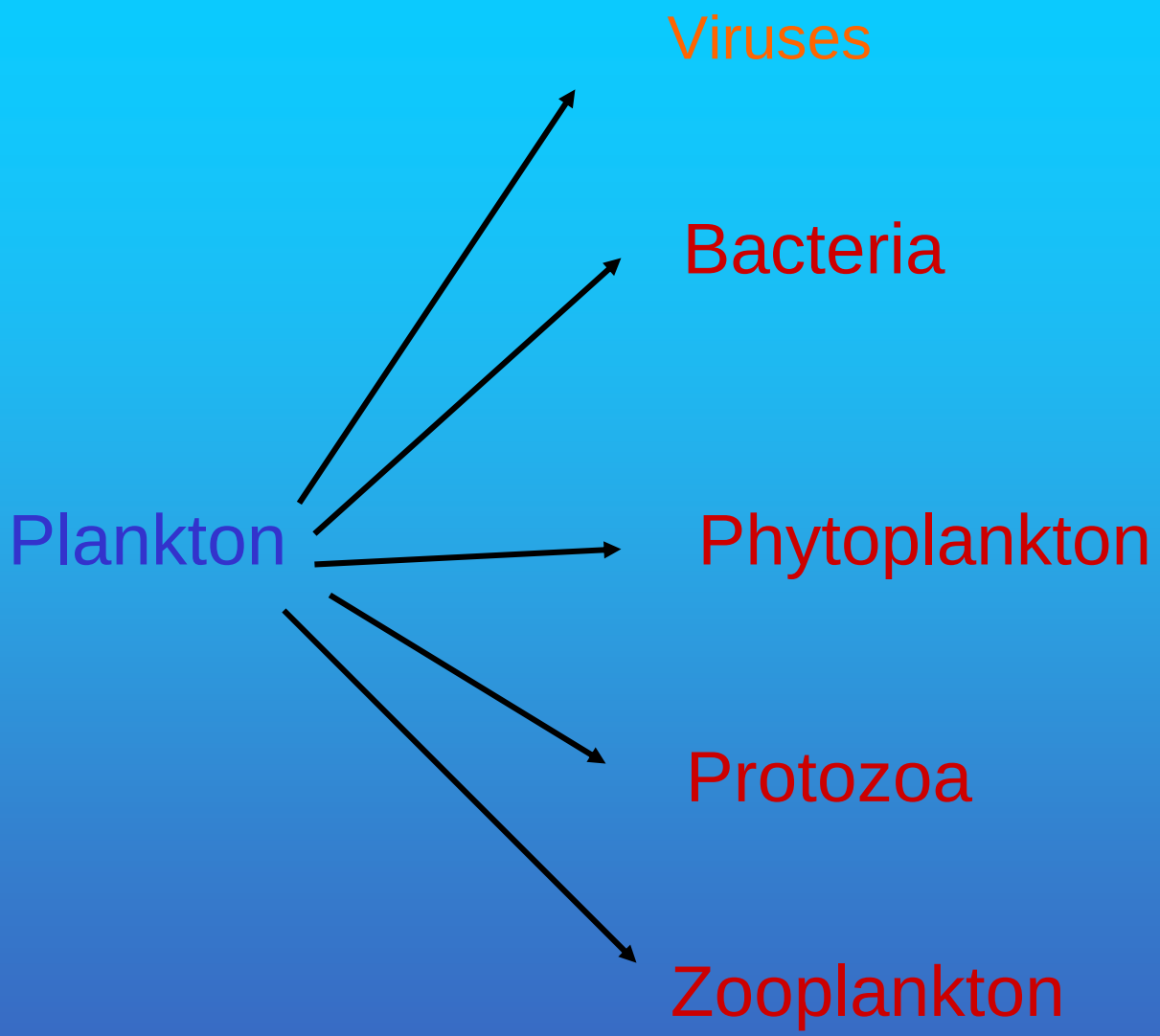


Plankton Classification



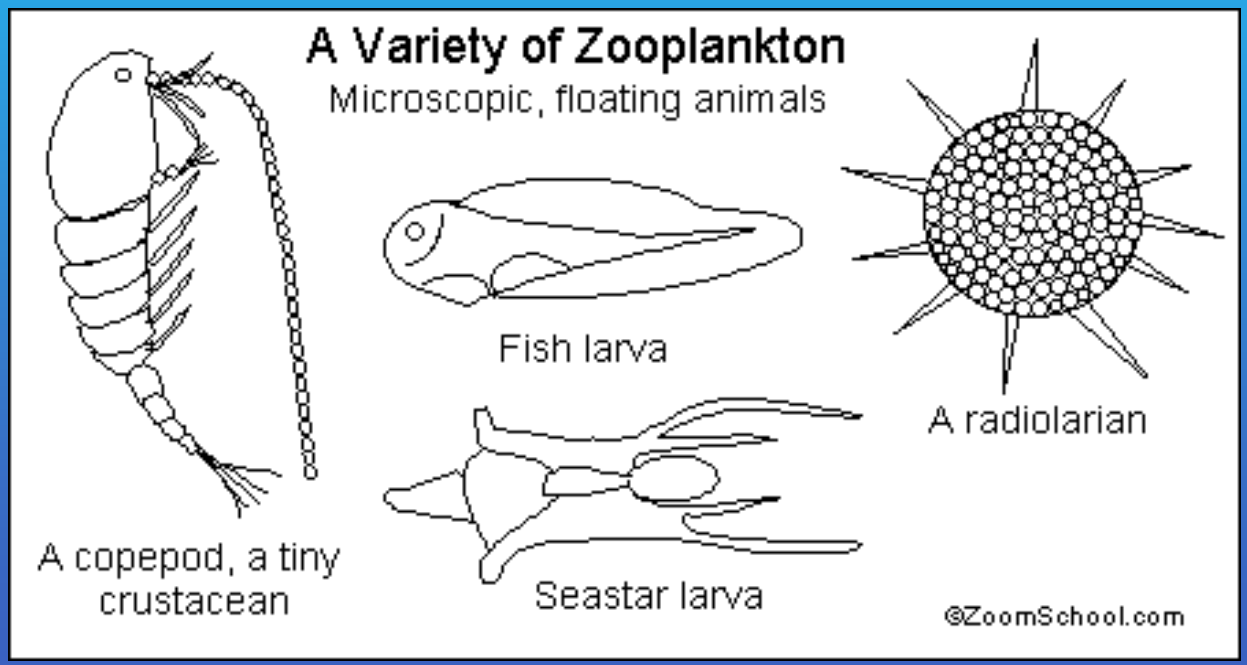






Zooplankton

- Drifting animals, organisms that eat other plankton



ZOOPLANKTON

- Animals that can swim and pursue prey.
- Radiolarians, Foraminiferans
- Crustacean
  - Copepods
- Gelatinous
  - Salps, larvaceans, ctenophores, jellyfish, pteropods

http://pandora.ucsd.edu/jaffelab/people/celeste/Intro/

Why study them?

- Most abundant animal on earth
- Secondary producers in marine systems
- Found in nearly every imaginable habitat
- Critical step in marine food chains
- Early life-stages of important commercial fish, shellfish
- Important in nutrient cycling

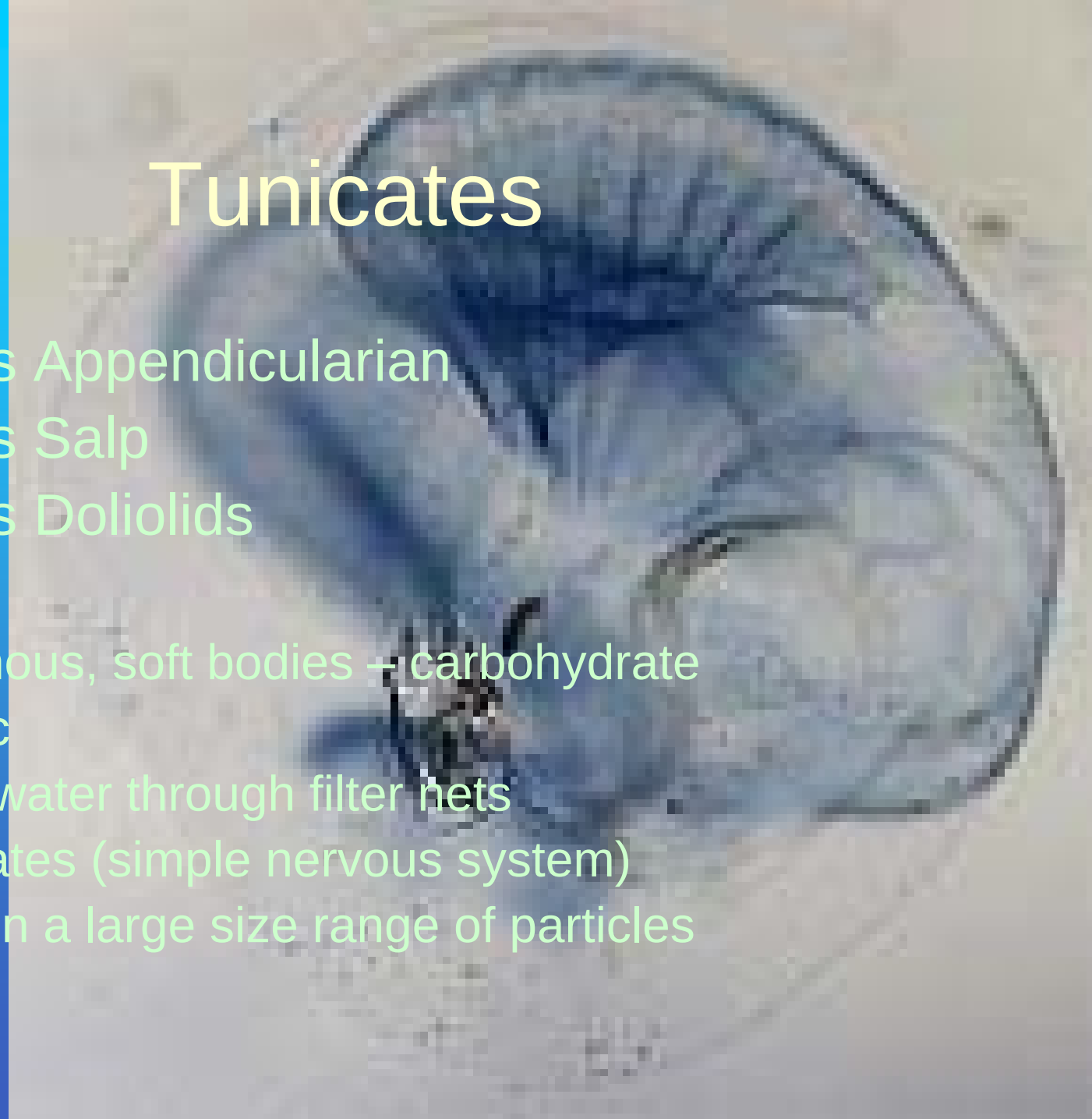
Important Zooplankton Groups

- Subclass Copepoda
  - Calanoide
  - Harpacticoids
  - Cyclopoids
- Sub-Phylum Tunicata
  - Larvacea (pelagic appendicularians)
  - Thaliacea (salps, doliolids, pyrosomas)

Copepods

- Phylum Arthropoda
- Class Crustacea
  - Hard exoskeleton (chitin)
  - Molt
  - Jointed appendages
  - 1 simple eye
  - Small (0.2 mm - >1 cm)
  - Fecal pellets with a peritrophic membrane

Tunicates

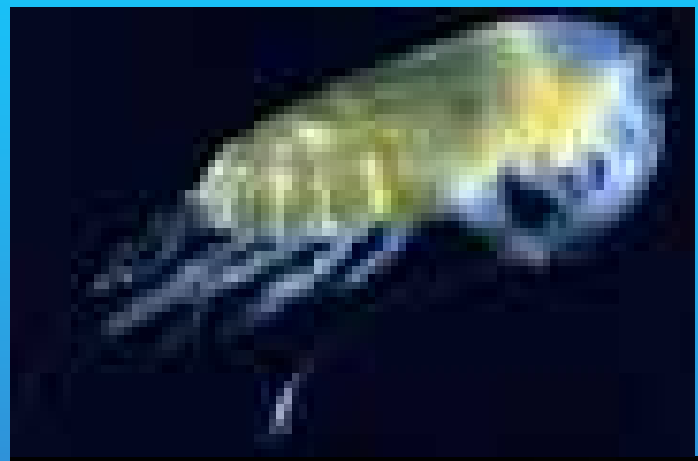


- Subclass Appendicularian
- Subclass Salp
- Subclass Doliolids

  - Gelatinous, soft bodies – carbohydrate
  - Pelagic
  - Pump water through filter nets
  - Chordates (simple nervous system)
  - Feed on a large size range of particles

Copepod-Images

Copepod-images



Gelatinous-images

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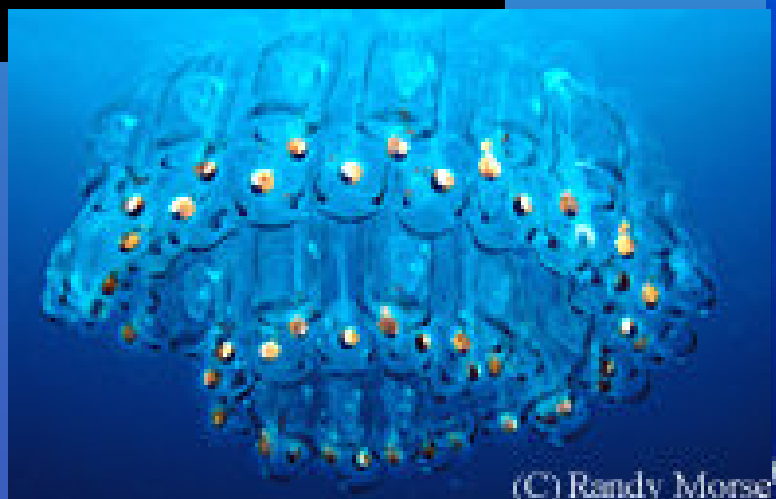
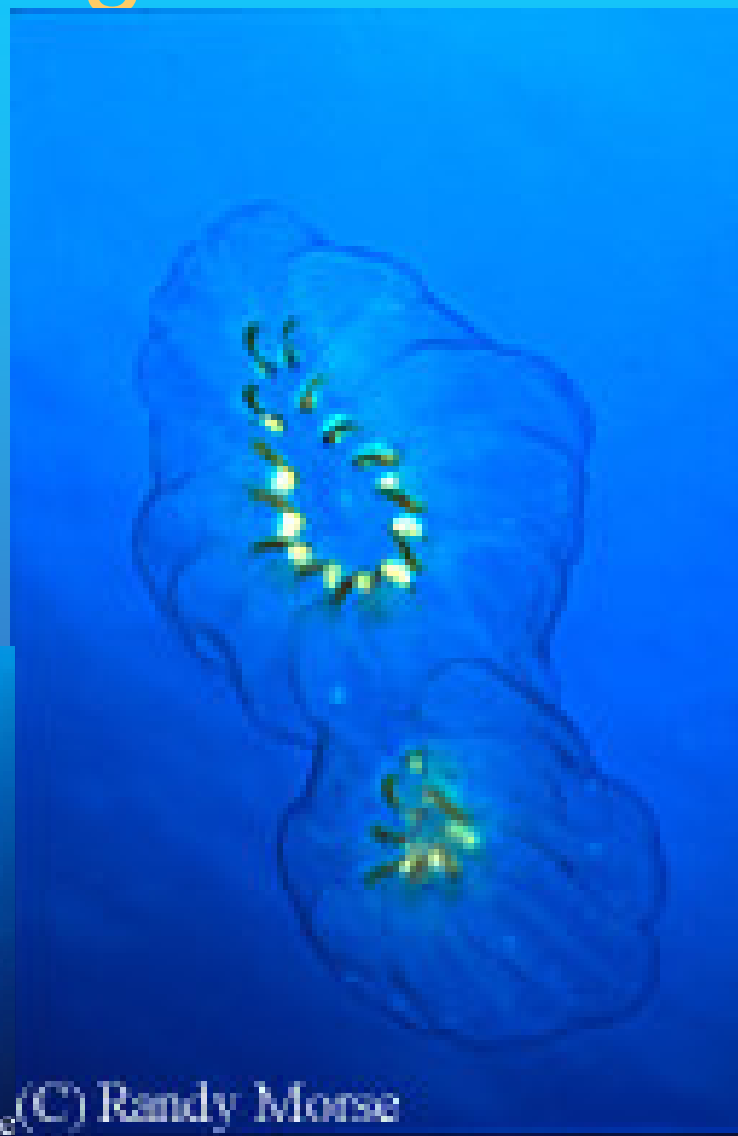
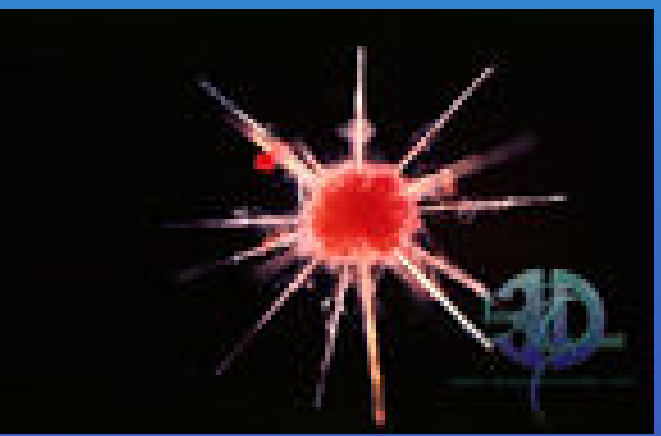
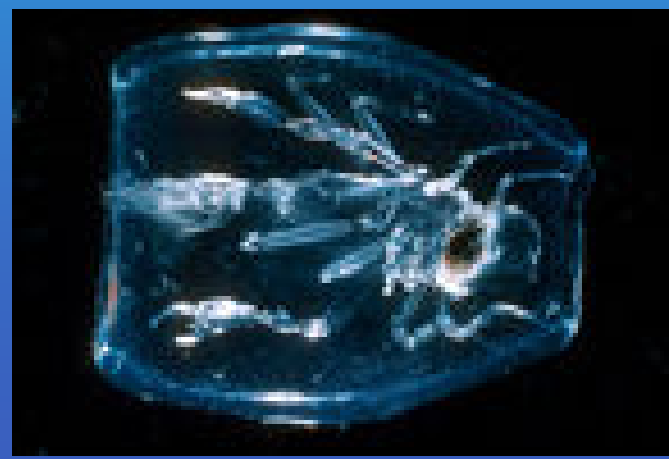


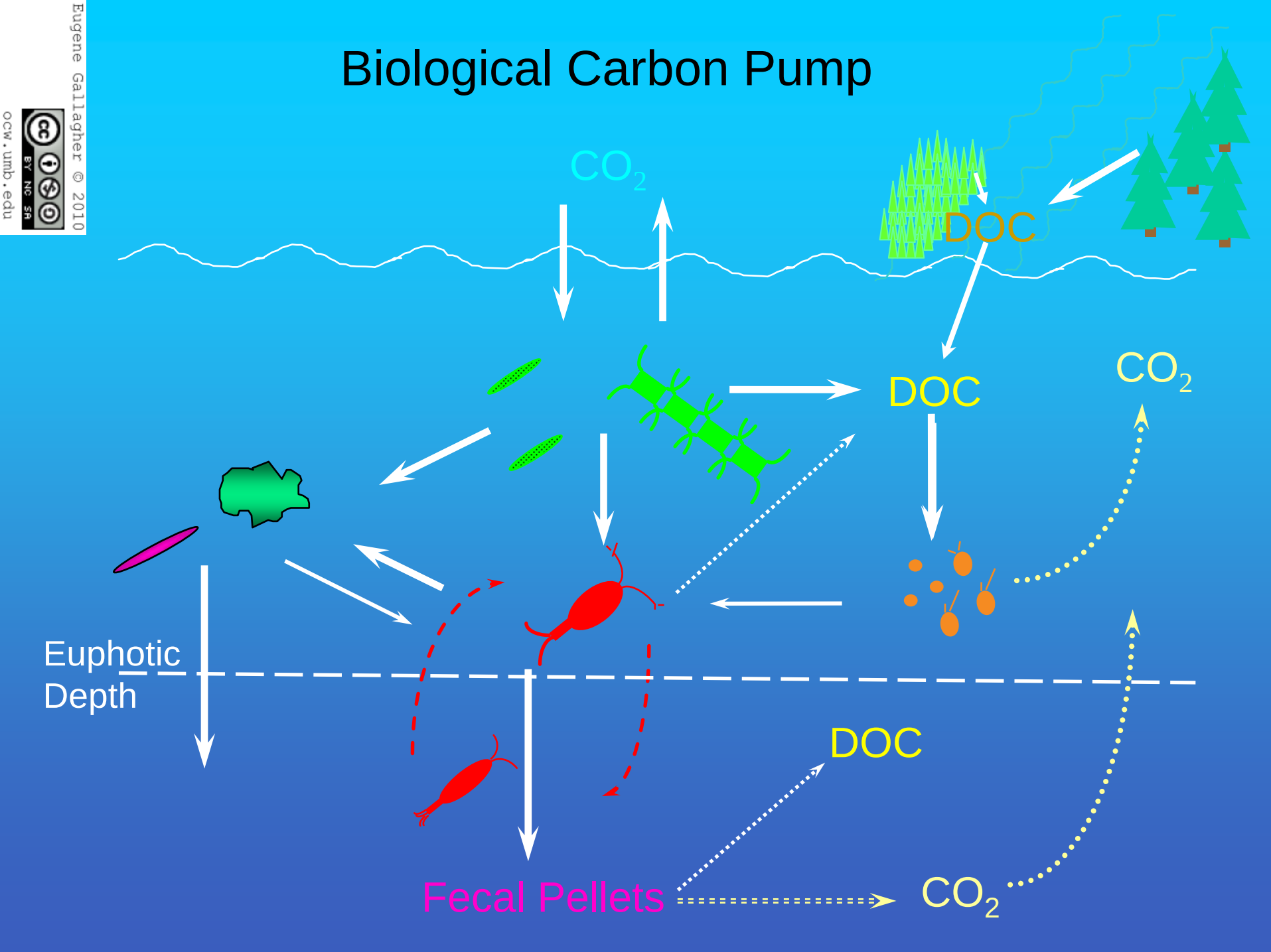


Other Zooplankton-images





Biological Carbon Pump



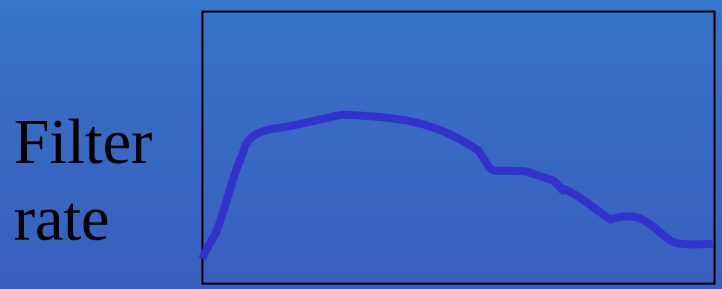
Grazing

- **Clearance Rate** = Grazing Rate: volume of water from which particles are completely removed
  - Efficiency: percent of particles remove (usually based on food quality or size)
- **Filtration Rate**: total volume of water passing the filter apparatus per unit time
  - 1 copepod filters 1 l of water per h and that water has in it;
  - 5 –50 um particles/l 100% efficiency
  - 10-20 um particles/l 100%
  - 50-2 um particles/l 10%
  - Clearance rate = 300 ml /copepod / h

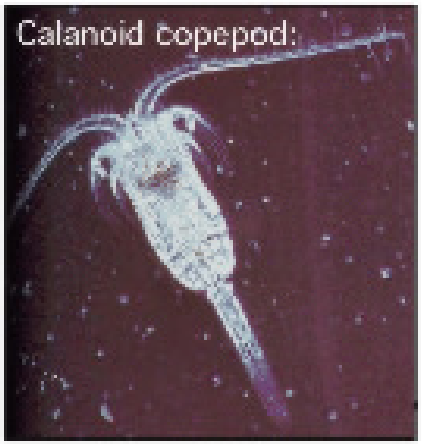
Grazing (continued)

- Ingestion Rate: amount of food passing through the gut per unit time
  - Units of chl, C or N

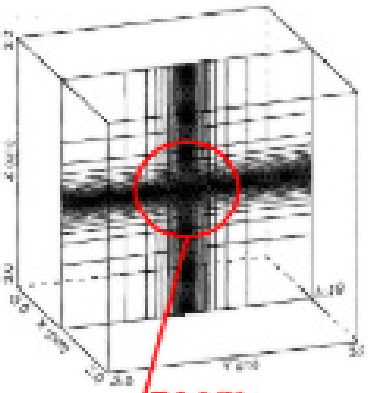
- Filtration rates are related to food concentration



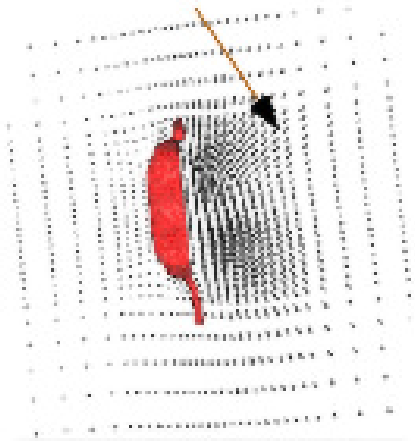
Filtration Currents

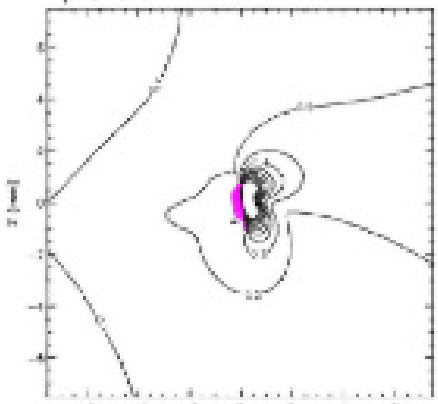


Computational domain:

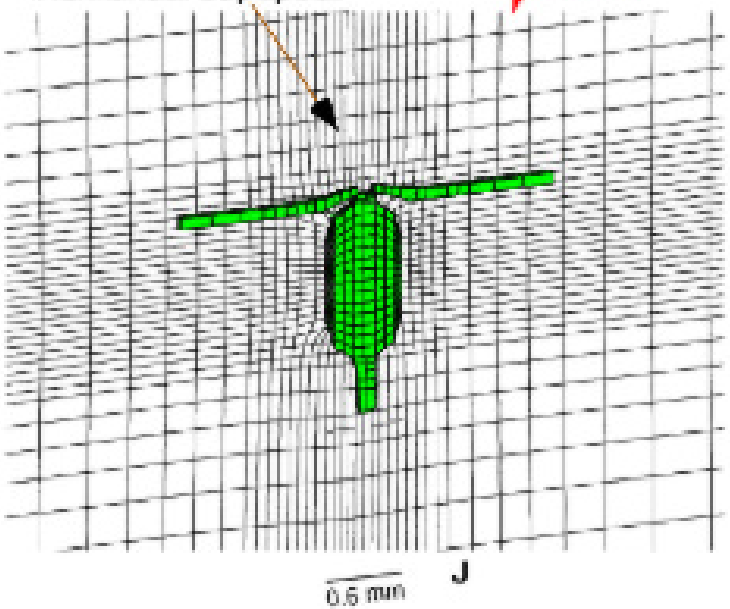


Predicted feeding current:





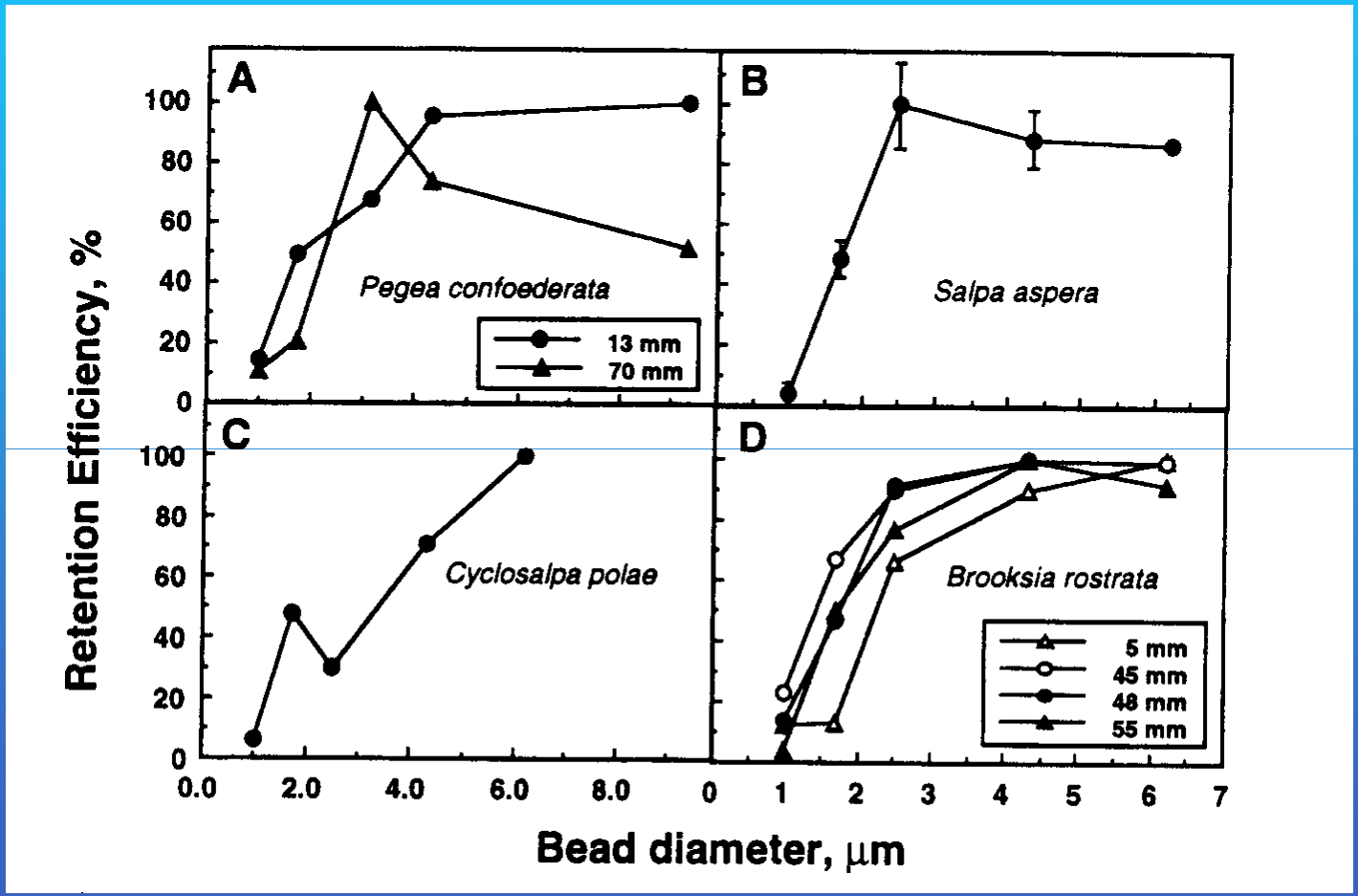
Numerical copepod:



Retention Size

- Determined by the distance between the setae on maxillae of copepods
  - Carnivores >> herbivores /omnivores
- Determined by the net spacing in tunicates

Efficiency Example



Grazing Types

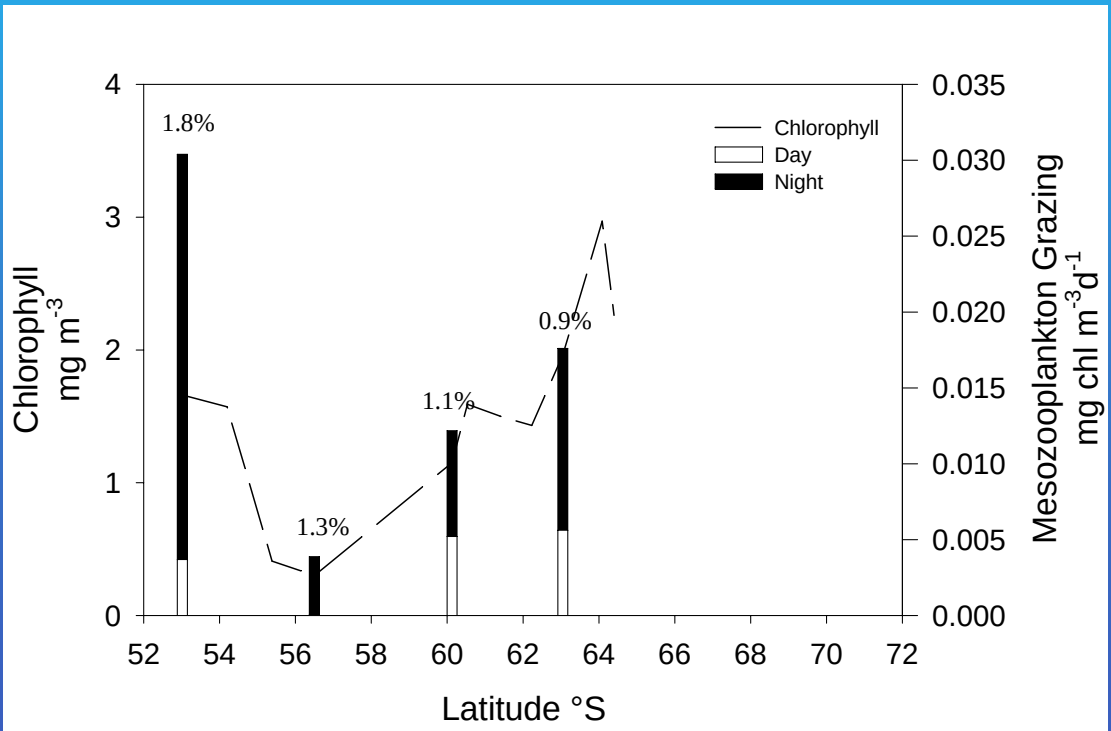
- Filtration: nonselective feeding, based on water currents
- Raptorial: may or may not be selective: grab a food item
  - Mechanical reception
  - Chemosensory

Limitations / Preferences for Grazing

- Size
- Nutritional content
- Taste
- Concentration
- Speed

Diel

- Copepods: increased feeding at night
- Tunicates: may or may not be diel



Seasonal

- Maximum in the spring
  - Temperate areas (spring, fall, summer, winter)
  - Polar areas (spring, summer, fall, winter)
  - Food supply (concentration and type)
  - Life cycle of the zooplankter

Spring

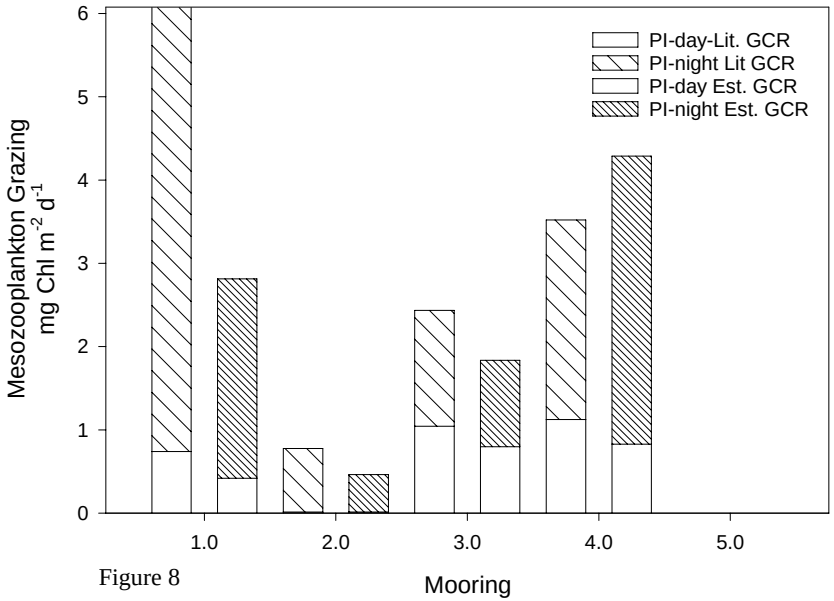


Figure 8

Summer

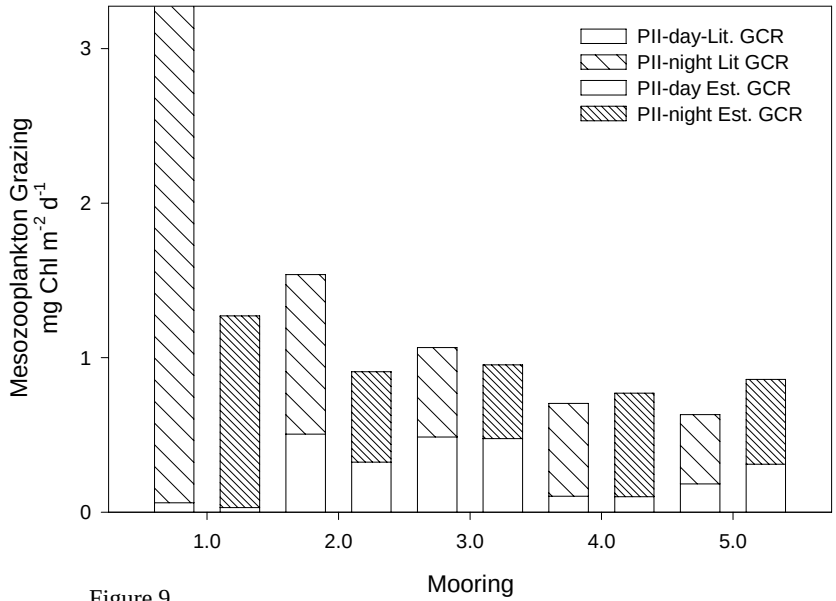
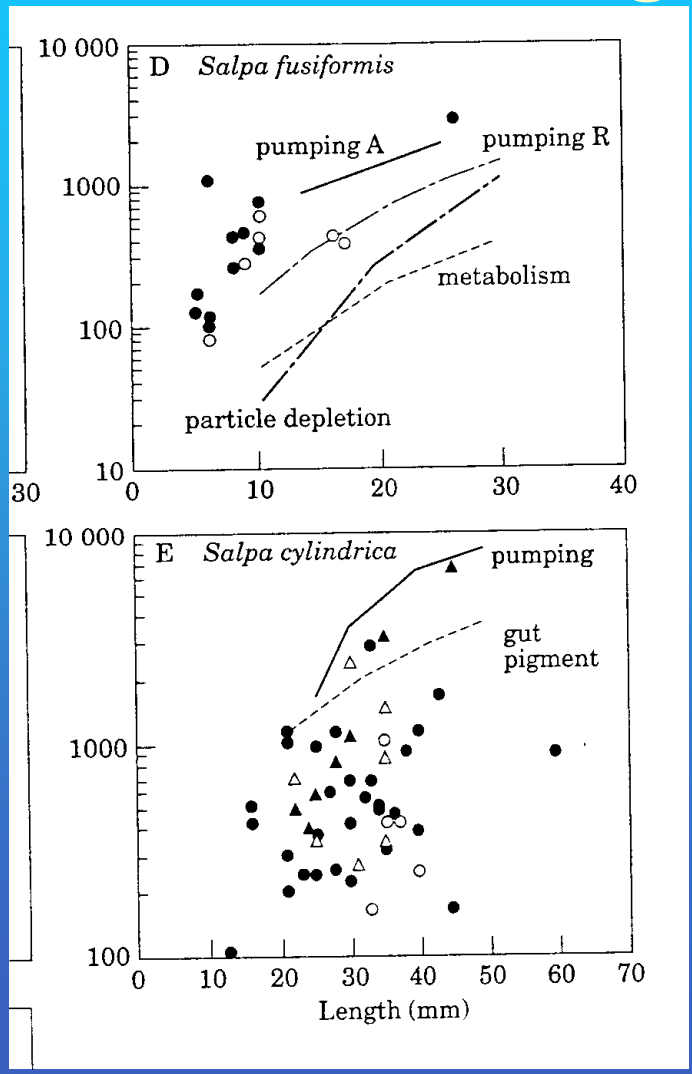


Figure 9

Methods for Grazing

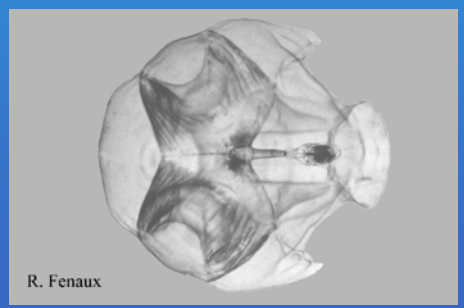
- Clearance Experiments
  - Change in the number of cells during an incubation
- Gut Pigment
  - Grazing on phytoplankton (depends on pigment destruction)
- Tracers
  - Fluorescent-labels
  - Microcapsules
  - C-14, H-3 thymidine

Examples of Grazing Methods



Zooplankton

- COPEPODS
  - Protozoa
  - Phytoplankton
  - Detritus



- GELATINOUS
  - –DOM
  - –Colloids
  - –Bacteria
  - –Protozoa
  - –Phytoplankton
  - –detritus

Particles for Export and Food

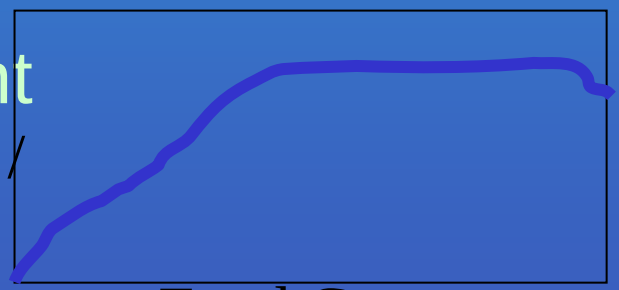
- What types of particles?
  - Feeding Appendages
    - Webs, houses
    - Gelatinous Zooplankton
  - Fecal Pellets

Excretion

- Release of soluble material
  - Ammonia (Urea, free amino acids, DOC)
  - Younger stages excrete more per unit weight (Not total volume)
  - Decreases with temperature
  - Related to grazing

Egestion: Fecal pellet production

- Release of solid material
  - High 7-17 C:N
  - Copepods: surrounded by peritrophic membrane
  - Depends on food concentration to a point
  - Linear relationship between ingestion rate and pellet production rate
  - Temperature dependent



Comparison between Copepods and Tunicates

Activity	Copepod	Tunicate
Grazing	Filter Smaller particle size (5-200) Raptorial feeder-selective	Filter Large particle size (.2-200) Nonselective
Digestion /assimilation	Higher assimilation (30-90%)	Assimilation (18-60%)
Respiration	Temperature	temperature
Egestion	Conc c & N down	Conc C & N up

Major Avenues of Focus Today

- Controls on toxic blooms
  - Grazed or not?
- Carbon cycle – Global warming
  - Grazing and flux of fecal pellets
- Biodiversity
  - Genetic studies
  - Extreme environments
- Human Health

Major Programs Around

- Eurapp (European Appendicularians)
- JGOFS (Joint Global Ocean Flux Study)
- TASC (Trans-Atlantic Study of Calanus finmarchicus)
- GLOBEC (Global ocean Ecosystem Dynamics)

Methods

- Nets
  - 1-size
  - Multiple size mesh
  - Multiple net frames
- Acoustics
- Cameras
  - *In situ*
  - Video
- Laser
- Diving
- Submersibles
- Fluorescence

1. Collection
   1. Abundance
   2. Distribution
   3. Experiments
2. Observation
   1. Behavior
   2. Distribution

Methods-Experiments

- Electrodes
- Chemical Analysis
- Molecular techniques
- Computers
- Internet

Zooplankton Ecology

- Who is there?
- What are they doing?
- How are they doing it?