1.89, Environmental Microbiology
Prof. Martin Polz
**Lecture 19**

- Predation (cont.)
  - o Viruses, protozoa

<u>Mechanisms of predation</u>

$10^7$-$10^8$/ mL

- o Viruses: typically thought to be highly specific because they dock onto cell surface structures.
  - – Proteins (example: transporters (broader host range))
  - – Lipopolysaccharides (LPS): "strain-specific"

$\Rightarrow$ Elimination of prey is highly strain specific

Predation may play role of selecting for non-optimally adapted strains

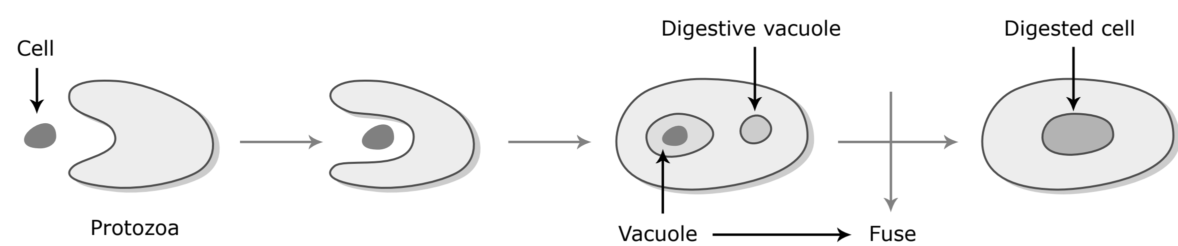
- – Encounter between viruses & bacteria is highly passive $\Rightarrow$ so concentration-dependant

  "kill the winner" = winners of competitive events may get wiped out

  Cell numbers (strictly speaking biomass can increase because cells grow bigger) $\rightarrow$ With more nutrients, rates speed up, but biomass stays the same due to predators.

- – If <u>prey density</u> (again, this is the specific prey organisms $\rightarrow$ total bacteria numbers can stay higher) drops below ~ $10^2$ cells/mL, virus predation is no longer an effective control. Predation and "kill the winner" are mechanisms that generate & maintain diversity with in communities

- o Protozoa:
  - – flagellates (few µm) – $10^3$ cells/mL
  - – cilliates (10 µm - mm) – 100 cells/mL




  - – motile & chemosensory abilities
  - – mostly non-selective predation

    $\rightarrow$ Selection for size. Example elongated shapes become enriched; attached bacteria are some what protected

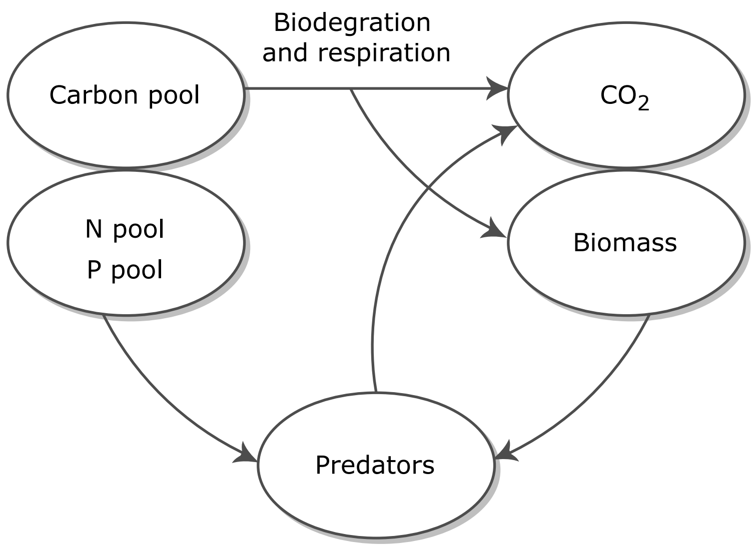
- o <u>Bdellorbrios</u>: bacterial predators (bacteria that prey on bacteria)

Ecological/Biological role of <u>predation</u>

- Keeps overall cell numbers (prokaryotic) relatively constant
- Keeps prokaryotic population at more or less steady state concentration
- Determines rates of biogeochemical cycles (when N or P is limiting) (have enough carbon)

Protozoa keeps [ $\delta$S ] and does not eliminate because encounter probability when numbers of prey

cycles nutrients because different C:N ratio } excess N released as ammonia




(bacterial C:N~5)

(Protozoan predators C:N~10)

**Microbial Community Structure**

- Terrestrial environments
- Land vs. Sea
- Principles of Microbial communities

- <u>Terrestrial environments</u> (soil)

Soil: complex matrix of mineral particles, organic debris and interstitial pore spaces that can be filled with water or air.

<u>Water is master variable</u> in soils because its presence leads to anoxygenic situation

$O_2$ concentration highly dependent on water content of soil.

Drying of soils: processes become water-limited

→ When pore spaces are filled with <1 μm of water, bacterial motility is impossible

→ When filled with 3-30 μm, predation becomes impossible.

Limiting nutrients → Bottom-up control
Predation → Top-down control

- Land vs. Sea

  - Aquatic → Relatively high transparency to light; turbulent mixing

    → scales of environmental gradients are large (example: small sample reflective of whole environment): horizontally: m → km
    vertically: cm → m

    Exception: particles of "marine snow"

  - Sediments and soils → principally structured by diffusion
    → scales: μm-mm (cm)

Carbon Substrates

- Aquatic: primary producer = algae
  - excretion of low MW C - compounds
  - organic matter has relatively low C:N ratio

- Terrestrial: primary producer = land plants
  - bulk of organic C is in structural polymers and secondary metabolites (tannins, phenolics, etc.)
  - humics
  - high C:N ratio (less nitrogen-fixation)

All microbial metabolisms are present (or have to potential to be). Only their relative importance will shift in a given environment (due to amount of energy-limiting substance).

Biogeochemical cycles governed by microbes and plants.