4. Suspension Feeders

- Benthic Boundary layers
- Feeding Types
  - Active
  - Passive
  - Facultative
- Feeding Mechanisms and Structures
- Altering Flow

Dr Rhian G. Waller
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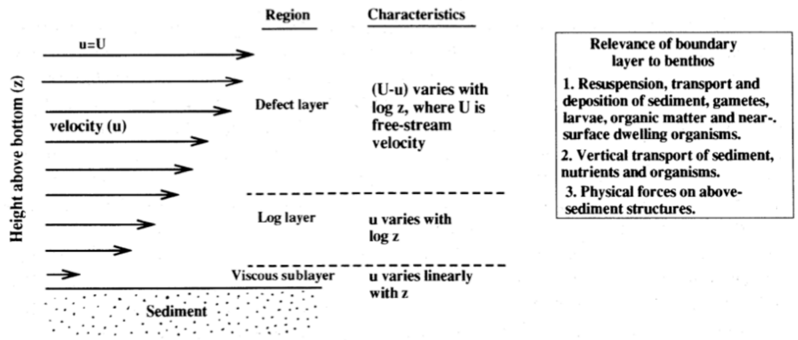
Reading: Wildish & Kristmanson, 1997, "Flow and the Physiology of Filtration"

Benthic Boundary Layers

- Important for both deposit and suspension feeders
  - Delivers food for the benthos
- Fluid motion over sediment
  - Region of shear near sea bed = boundary layer
  - Current = 0 at sea bed
  - Current = mean-stream velocity at top of boundary layer
- Boundary layer properties depend on
  - Flow properties (Reynolds number)
  - Background turbulence
  - Fluid properties (salinity, temp stratification, sedimentation)
  - Boundary characteristics (roughness, type of sediment)

Benthic Boundary Layers



- Resuspension, transport and deposition of
  - Sediment & organic matter
  - Gametes & larvae
  - Near surface bottom dwellers
- Vertical transport of sediment, nutrients & organisms
- Physical forces on above sediment structures

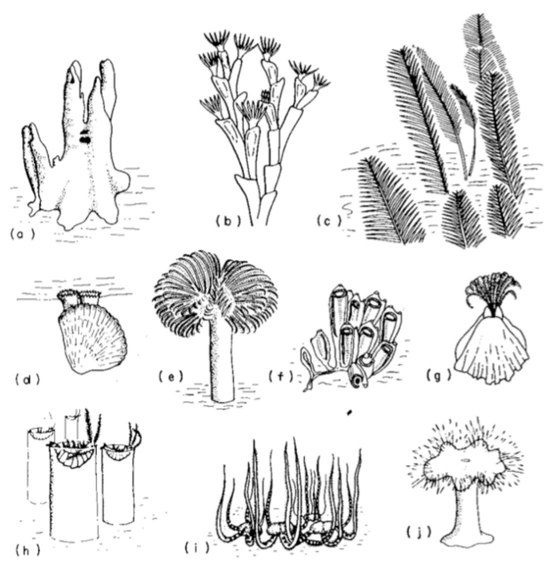
Feeding

- To feed – complex!
  - Get the food
  - Retain the food
  - Digest the food
- Require specific structures and strategies
  - Deposit Feeders
    - Eat lots of low nutrition sediment to get at the good particles
    - Eat all the time
  - Suspension Feeders
    - Trickier to find & retain!

Suspension Feeders

- Have structures that protrude into benthic boundary layer
- Protuberances affect water movement within the benthic boundary layer
  - Capture and Keep food particles from moving water
- Can be infauna or epifauna
  - All shapes and sizes

Suspension Feeders



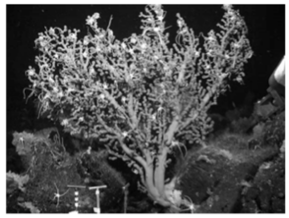
- Most found –
  - High currents
  - Hard substrates
  - Substrates with no fine silt

Fig. 9.4 Filter-feeding benthic animals: (a) the sponge *Amphilectus*; (b) the bryozoan *Bugula*; (c) the hydroid *Aglaophenia* with its flat surface at right angles to the prevailing current; (d) the bivalve *Cerastoderma edule*; (e) the polychaete *Bispira volutacornis*; (f) the tunicate *Clavellina lepadiformis*; (g) the barnacle *Balanus balanoides*; (h) the amphipod *Haploops tubicola*; (i) the brittlestar *Ophiothrix fragilis*; and (j) the anemone *Metridium senile*. (After Hughes 1980b.)

Barnes & Hughes, 1988

Feeding types

- **Passive**

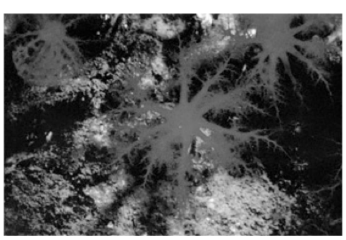


- **Active**

- **Facultative**

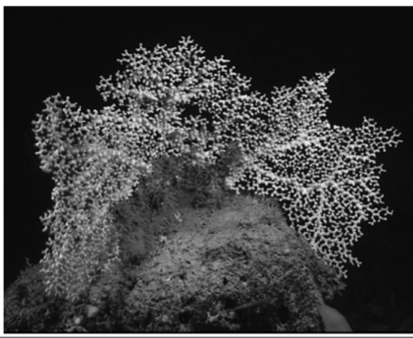
Passive Suspension Feeders

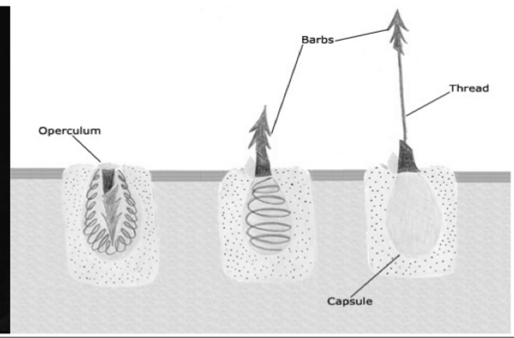
- Energy usage
  - Expend little energy getting water to them
  - Expend lots of energy in capturing food
- Strategy
  - Optimal positioning
  - Efficient filters
  - Efficient capture/subdue mechanisms



Passive Suspension Feeders

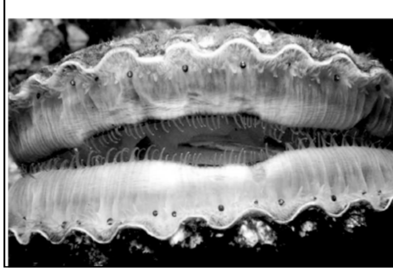
- **Cnidarians**
  - Orient themselves to current
    - Corals – fixed
      - Larval orientation important
    - Anemones – motile
      - Move with the current
  - Use stinging cells to retain and subdue prey

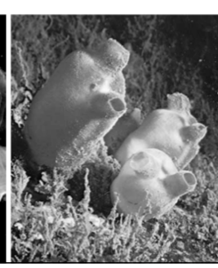




Active Suspension Feeding

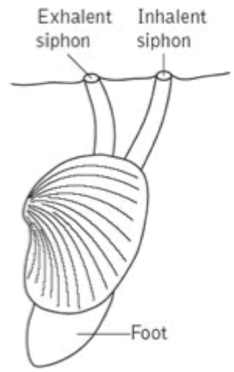
- Individual must supply its own energy to transport water over filtration surface
  - Filter large amounts of water
    - Capture lots of food
  - Don't need such complex retaining strategies

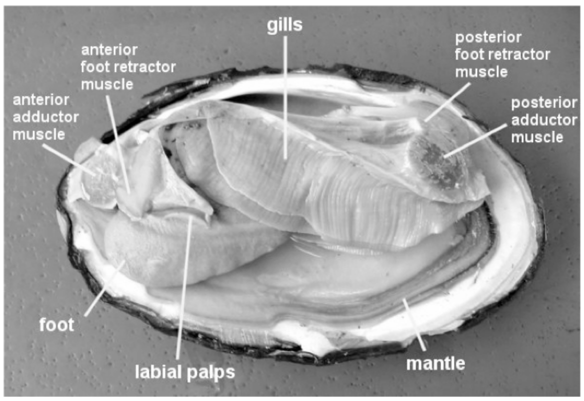


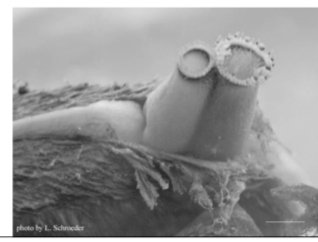


Active Suspension Feeding

- **Bivalve Molluscs**
  - Inhalent & Exhalent siphons
  - One way transport of water
  - Efficient, large, gills for filtering

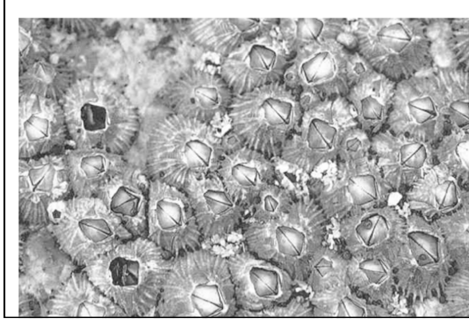






Facultative Suspension Feeders

- Individuals can switch from passive to active feeding and back again
  - Switch when ambient flow changes
  - High Velocities = Passive
  - Low Velocities = Active



Facultative Suspension Feeders

- **Barnacles**
  - Fast sweeping of cirri in slow moving water
  - Extend cirri out in fast moving water

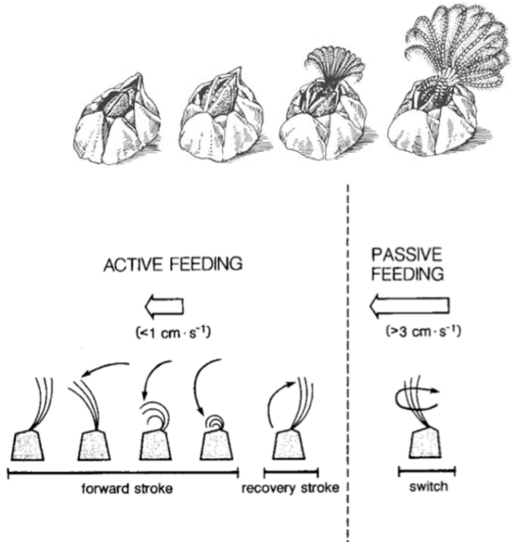
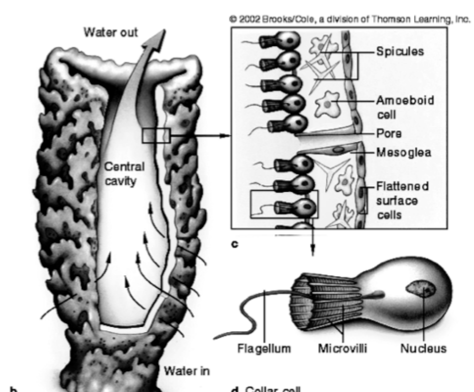


Figure 4.11 Active and passive feeding in *Semibalanus balanoides* (Trager et al. 1990).

Combined Suspension Feeders

- Individuals have both passive and active mechanisms that work simultaneously
- **Sponges**
  - Pore spaces
  - Flagella
  - Passive flow is induced
    - Pressure differences

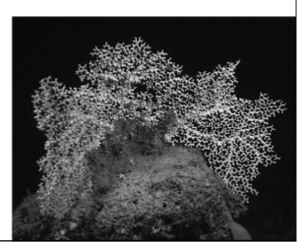


Types of Suspension Feeders

- Passive Suspension Feeders
  - Go with the flow
    - But need good retaining mechanisms
- Active Suspension Feeders
  - Alter the flow
- Facultative Suspension Feeders
  - Swing both ways
- Combined Suspension Feeders
  - Do both at once

Mechanisms of Capture

- Must process large volumes of water
  - Filter particulate matter
  - Low concs (few mg/L)
- Need efficient capturing mechanisms/filters
  - Many species use mucus
- Many species have morphologies suitable for trapping flow
  - Face prevailing current
  - Body pattern slows flow
    - Concentrates food particles



Altering flow

- Organisms can develop "whole body" strategies
  - *Lanice conchilega*

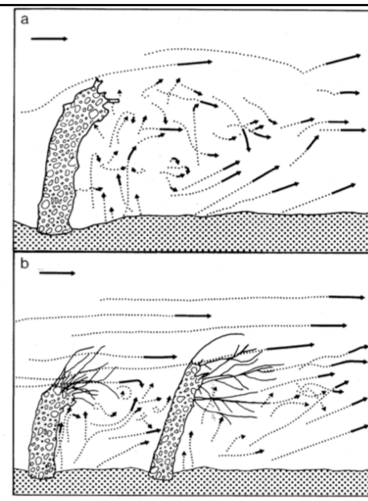


FIG. 3. Velocities of egg particles resuspended in the wake envelopes of *Lanice conchilega* tubes, measured from pathlines on flume photographs. Vector length represents length of pathlines relative to mean length of undisturbed pathlines calculated for each photograph. Lengths of pathlines are equivalent to time averaged velocities of particles. Reference vector (100% of channel flow velocity) in upper left. Dot lines are observed pathlines. Channel flow velocity $10-11\ cm \cdot s^{-1}$ in all photographs. (a) Adult tube, built in tank, fringe not present. Summary of eight photographs ($\frac{1}{8}$ to $\frac{1}{2}$ s exposure). Mean percentage of channel flow velocity of particles within wake envelope is 35.08 ± 6.27 (at 95% confidence level, $n = 46$). (b) Adult tubes, natural spacing, orientation and fringes. Summary of six photographs ($\frac{1}{8}$ to $\frac{1}{2}$ s). Mean percentage of channel flow velocity of particles within wake envelopes is 31.47 ± 7.64 (95% CL, $n = 30$). Tubes are 0.5 cm wide.

Carey, 1983

Conclusions

- Benthic Boundary Layer
  - Organisms have to work with the boundary layer to get food particles
- Four types of suspension feeders
  - Passive
  - Active
  - Facultative
  - Combined
- Mechanisms of capture
  - Filters
  - Mucus
  - Body shapes

r/K Selection Theory

- MacArthur & Wilson
  - Island Biogeography
- "Selection of combinations of traits in an organism is a trade-off between quantity or quality of offspring"
  - Increasing quantity of offspring at expense of parental investment
  - Reduced quantity of offspring at increased parental investment
  - Selective pressures hypothesized to drive evolution

r/K Selection Theory

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

r – Growth Rate

N – Population

K – Carry Capacity

r/K Selection Theory

- **r Selected**
  - Reproduce quickly
  - High fecundity
  - Early maturation to adult
  - Short life span
  - Small body size
- Unstable Environments
  - Suitable for life in habitats that change over small time scales
- E.g. Barnacles, polychaetes

- **K Selected**
  - Extensive parental care
  - Low fecundity
  - Long maturation time
  - Long life span
  - Larger body size
- Stable Environments
  - Suitable for life in stable, unchanging environments
- E.g. Corals, deep-sea organisms