Marine Invertebrates

I. Phylum Echiura and Phylum Sipuncula
II. Phylum Mollusca
III. Phylum Arthropoda, Subphylum Crustacea
IV. Phylum Echinodermata
V. Phylum Chordata, Subphylum Urochordata

I. Phylum Sipuncula

• Peanut worms
  – unsegmented, bilateral worms
  • resemble peanuts!
  – all marine, benthic
  • live in burrows, open at one end
  – 350 species
  • sexual reproduction only
  • external fertilization

II. Phylum Echiura

• Spoon worms
  – unsegmented, bilateral worms
  – 100 species
• Fat innkeeper worm (*Urechis caupo*)
  – U-shaped burrows in mud
  – shares burrow with commensals
  • goby
  • pea crab
  • scale worm
  – burrows help aerate mud
  – builds mucus net for filter-feeding
III. Phylum Mollusca

- 2nd largest phylum of marine inverts >100,000 spp.
- Snails, slugs, chitons, squids, clams, etc.
- Diverse habitats and lifestyles
- Soft bodies
  - bilateral symmetry
- Hard shell
  - good fossil record

III. Phylum Mollusca

- Calcareous (CaCO$_3$) shell
  - secreted by mantle (layer of tissue)
  - 1 to several pieces
  - exoskeleton
- Muscular foot
  - creeping, clamping, burrowing
- Radula – feeding structure
  - scraping
  - lost in some groups (e.g., bivalves)

III. Phylum Mollusca

- Molluscan lifestyles
  - some benthic, some pelagic
  - intertidal to deep sea
  - herbivores (use radula to scrape)
  - predators
  - filter feeders
- Reproduction
  - most dioecious, some hermaphroditic
  - most – external fertilization
  - most – trochophore larva
**Molluscs - Class Gastropoda**

- “stomach foot”
- Snails, limpets, abalones, sea slugs
- Diverse habitats, feeding styles, reproduction

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**Gastropod diversity - snails**

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**Gastropod diversity - sea slugs**

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**Molluscs - Class Bivalvia**

All are filter feeders!
Clam using foot to bury itself

Molluscs - Class Cephalopoda

- “Head foot”
- Smart! Probably have an IQ
- Big head, complex brain
  - camera eye – forms images!
- Communicate/camouflage with skin
  - change color, texture
  - bioluminescence

Molluscs - Class Cephalopoda

Cephalopod behaviors
Video

Molluscs - Class Polyplacophora
• “many plate bearer”
• The chitons
• 8 shell plates on back
• Grazers

III. Phylum Arthropoda, Subphylum Crustacea
• Arthropoda = “jointed foot”
  – Subphylum Crustacea
  – plus spiders, insects (most species of any animal group)
• Largest group of marine inverts
  – at least 100,000 species
  – crabs, lobsters, barnacles, MANY others

Crustacean bodies
• Jointed exoskeleton made of chitin
  – protection
  – must be molted
• Bilateral, segmented
  – head, thorax, abdomen
• Lots of paired appendages
  – legs, mouthparts, claws, etc.
• Dioecious (exc. barnacles)
  – planktonic nauplius larva
**Crustacean groups**

- Malacostraca
  - crabs, lobsters, shrimps, krill, MANY others
- Copepoda
  - copepods
- Cirripedia
  - barnacles

**Malacostracans - some local crabs**

- red rock crab
- lined shore crab
- mole crab

**Hermit crabs - 1 shell isn't enough**

**Other malacostracans**

- an isopod ("same foot")
- California spiny lobster (*Panulirus interruptus*)
- an amphipod
Copepods

- Holoplankton
- Graze on phytoplankton
- Very numerous
  - imp. food source

Cirripedia - the barnacles

- SIZE MATTERS!!
- Barnacles are sessile crustaceans
- Barnacles are simultaneous hermaphrodites
- Barnacles have non-motile sperm
- How does a barnacle maximize its reproductive success?
  - By having the longest penis in the animal kingdom!

IV. Phylum Echinodermata

- “spiny skin”
- Deuterostomes!
  - mouth forms second in development
  - links echinoderms and chordates
- 7000 species, all marine
- Bilateral as larvae
- Pentaradial as adults
- Endoskeleton
  - CaCO₃ plates and spines
- Water vascular system

The H₂O vascular system

- Nifty set of hydraulic canals
- Visible externally as tube feet
  - extended, retracted
- Locomotion and/or feeding
Echinoderms – Class Asteroidea

- "star-like"
- The sea stars
- 5 arms (generally)
- Feed by extruding stomach

- crown-of-thorns star
- bat star
- sunflower star

Echinoderms – Class Ophiuroidea

- "snake-tail-like"
- The brittle stars and basket stars
- Central disc distinct from arms

Echinoderms – Class Echinoidea

- "hedgehog-like"
- The sea urchins and sand dollars

- Aristotle’s lantern
How do you get pentaradial symmetry from a globular animal??

Echinoderms - Class Holothuroidea
- The sea cucumbers!
- Bilateral AND pentaradial symmetry

Cuke anatomy

Sea cucumber biology
- Deposit or filter feeders
- Spew their guts out!
And now a look at our closest invertebrate relatives....

...the invertebrate chordates

V. Phylum Chordata

- Verts and inverts
- 4 chordate characteristics:
  - gill slits
  - dorsal, hollow nerve cord
  - notochord – stiff, muscular support for...
  - post-anal tail
- Invertebrate chordates
  - urochordates – sea squirts + others
  - cephalochordates – lancelets

Chordate characteristics
Subphylum Urochordata

- All marine filter feeders
- Benthic or pelagic
- Adults lose chordate characteristics
  - only gill slits remain
- Solitary or colonial
  - sex + asex
- All hermaphroditic
  - tadpole larva

A tadpole larva

- Short planktonic duration
- Settles near parent
- Resorbs tail, notochord, nerve cord
- Begins filter feeding

Subphylum Urochordata

- Class Ascidiacea
  - the sea squirts
  - body covered in cellulose tunic
  - benthic
  - oral (H₂O in) and atrial (H₂O out) siphons on same end of body

Some sea squirts

- Light-bulb tunicates
- Solitary stalked tunicate
- Squirts on squirts!
Subphylum Urochordata

- Class Thaliacea
  - holopelagic salps
  - oral and atrial siphons at opposite ends
  - occur seasonally in huge numbers
    - can clear water of smaller plankton

Salp aggregations

- Subphylum Urochordata
- Class Larvacea
  - the holopelagic larvaceans
  - tadpole-like adults
  - live in mucus house!
    - wave tail pulls H₂O through house
    - food caught on mucus
    - animal eats mucus
    - dumps house when clogged → “marine snow”

Larvacean anatomy
Larvaceans - the tadpole larvae that never grow up?

- Mucus "house" - two meshes
- Larvacean tail
  - No benthic stage
  - Build several houses every day
    - Filters clog fast
  - Marine snow
    - Feeds deep sea
    - An ecological community

Setting the record straight