Oceanography Chapter 15: Marine Animals

Heterotrophic – cannot synthesize their own food
Eat autotrophs or lower level heterotrophs
True multicellular critters arose 700-900 MYA (Proterozoic Eon)
  ➢ about 2 BY after cyanobacteria put out enough free oxygen into the atmosphere
  ➢ O₂ Revolution - 1% to 20 % in 1.5 BY
  ➢ O₃ formed – allow for critters to leave the water 400 MYA

Early views of life
Burgess Shale of B.C. “It’s a Wonderful Life”
Ediacara Hills of Australia
Chengjiang beds of SW China

Phylum- group of critters that share similar architecture, level of complexity and evolutionary history (phylon- tribe)
  ➢ 90% of all living animals are invertebrates
  ➢ 33 invertebrate phyla (show you 9)

**Phylum Porifera** (Pons = holes, ferre – to bear)-aka {Sponge Bob}
  ➢ nearly all of the 10,000 species are marine
  ➢ Size: bean to a small car  ⇒ Have spicules made of spongin (CaCO₃, SiO₂)
  ➢ Widespread
  ➢ Shapes  ⇒ Branching, vase-like, encrusting
  ➢ Suspension Feeders – strain plankton (400 gallons)
  ➢ No digestive system, no circulation, respiratory or nervous systems

**Phylum Cnidaria (old Coelenterata)**
  ➢ 9000 species – jelly fish, sea anemones, corals
  ➢ cnidoblasts – stinging cells (Figure)
    (knide – nettle, blastikos – blast upward)
  ➢ Also have migratory cells which move nutrients around
  ➢ Cells
    1. Gastrodermis – digestion and reproduction
    2. Epidermis – protection and capture of prey
  ➢ Radial symmetry – body parts radiate from a central axis like spokes on a wheel
  ➢ No exeretory or circulatory system
  ➢ Primitive network of nerves
  ➢ Two forms (of body)
    1. Medusae – jelly fish
      ➢ Biggest – cyanea – 12 ft bell, 59’ tentacles
      ➢ Sea Wasp – 50 ft tentacles can kill you in 3 minutes (Chironix)
    2. Polyp – many footed
      ➢ Fixed typically
      ➢ Corals, sea anemones
      ➢ Corals – solitary – 12 inches diameter
Colonial – ant sized – Hermatypic
- Zooxanthellae- dinoflagellates – symbiotic
- Prefer clear water
- Higher salinity – therefore, freshwater is deadly

**Worm Phyla**
- Transition to more advanced
- Bilateral symmetry – left side, right side
- Have head with sensory tissue
- Some flow through digestive systems and excretory systems

1. Simplest – **Platyhelminthes** – flat worms
   - Platys – flat Helmins- worm
   - Parasites – tapeworms of vertebrates
   - Most are free- living scavengers and predators
   - Few are greater than 1 ¼ inches in length
   - Most primitive with a central nervous system with brain and light sensitive eye spot
   - Larger flatworms lack a true respiratory an excretory system
   - Eliminate wastes by diffusion through cells
     (therefore, their body can be no more than a few cells thick)

2. **Nematoda** (Round worms) (nematos – thread)
   - Flow through digestive tract (mouth, butt)
   - Plentiful in almost all habitats
   - Most of the 12 k species are free living
     - Although some are parasitic (sushi)
       - Plentiful 1 meter square by 4 cm thick=4,420,000 critters

3. **Annelida** Cannelus – ring
   - Includes earthworm
   - Advanced, segmented (Metamerism)
     - Each segment can have its own nervous, muscular and repro tracts
   - Class Polychaetae (chaetae – bristles)
     - (Figure) – most important marine annelid
       - 1-15 cm (1/2 to 6 inches)
       - Feather duster- catches food
       - Some are mobile, others in tubes

**ADVANCED INVERTEBRATES**

**Phylum Mollusca** (Molluscus – soft bodied) - Figure 15.10
- Contains 80k (second to Arthropoda)
- Clams, snails, octopus, squid
- Most are marine and have a shell –internal
  - external
- Some species –acute eyesite, intelligence - octopus
- Probably came from a common ancestor of annelids
- Bilateral, heads, digestive tracts, nervous systems (a few are segmented)
- Structural diversity, can achieve great size
1. **Gastropoda** – Snails
   - Abalone, conch, limpet, garden snail
   - Grazers, suspension feeders, predators and a few are planktonic
   - Beautiful shells – outside – shock absorber
     - middle- CaCO₃ – strength
     - inside- smooth
   - Some do not have shells – Nudibranch (Figure)

2. **Bivalvia** – twin shells
   - Clams, oysters, mussels
   - Surrender mobility for protection, suspension feeders

3. **Cephalopods** (head foot- literal)
   - Nautilus, Octopus, Squid
     - external
     - none
     - small one (shells)
   - Squid and octopus more advanced
   - Secrete an ink roughly their body size
   - Squid – 59 feet long
   - Squid – largest invertebrate
   - Octopus- most intelligent – keen eyesight
   - Only 450 species of cephalos now

**Phylum Arthropoda**
- Arthron (joint) poda – foot
- Lobsters, shrimps, crabs, krill, barnacles
- Million of species
- Most successful phyla
- Krill-greatest biomass
- Variation of annelid – per or pairs of legs (or appendage) per segment
- All are bilaterally symmetric
- Do not have good nervous system, intelligence or eyesight
- But do have 3 major advances
  1. Exoskeleton – form fitting external covering
  2. Striated Muscle – Quick, strong, lightweight form of muscle that makes rapid movement and flight possible
  3. Articulation – ability to bend appendages at specific points
- Exoskeleton – made of chitin (N rich carb)
- Molting – replacement of exoskeleton
- Largest class – *insecta* – all marines ones are water striders
- **Crustacea** – 30 k – primarily marine – gills
  - Lobsters, crabs
  - Bodies – 16 to 20 segments
  - Big – King Crab – leg span of 12 feet
  - Heaviest- lobster (48 lbs) feed 10 people
  - Dominate oceans

**Phylum Echinodermata**
- Echinos (hedgehog, skim)
- Lack eyes, brains
- 6000 species
- Radial symmetry (Pentamerous)
Five classes
1. Asteroidea – sea stars – water vascular system
2. Ophiuroidea – Brittle stars – leave an arm
3. Echinoidea – sea urchins, sand dollars
4. Holothuroidea – sea cucumbers

Figures 15.18-15.20 (15.18 - Sea Star, 15.19 – Water vascular, 15.20 – Brittle stars)

**PHYLUM CHORDATA**
- Possess notochord
- 40k species
- about 5% lose notochord – invertebrate chordates

1. Invertebrate chordates (Figure 15.22)
   - Tunicates – sea squirts
   - Suspension feeders – look like sponges
   - Amphioxus (sharp at both ends)
   - Invertebrate with some vertebrate features

2. Vertebrate chordates
   a. Fish – possess gills, fins
      - More than all other vertebrates combined
      - Length – 0.4 inch to 60 feet
      - Weight – 0.1g to 45 tons
      - Speed – 75 mph (120 km/hr)
      - Cold blooded – ectothermic
      - 40% freshwater, 60% sea water
      - 500 MYA first appeared, exploded 410 MYA
      - Devonian Period (age of fish) – 408 –360 MYA
        1. Class Agnatha – hagfish, lanpreys (Figure 15.25)
           - Fewer than 50 species
           - Slime to protect
           - Lanpreys - parasitic
        2. Class Chondrichthyes
           - 280 MYA appeared
           - sharks, slates, rays, chamaeras
           - active
           - cartilage skeleton
           - sharks, rays – neg. buoyancy (no gas bladder) - (they’ll sink)
           - diversity
           - more people are killed by dogs each year than killed in the last century by sharks

Sharks
- 80% of shark species are less than 2m long as adults
- Great White – 23 feet, 3000 lbs
- Mako - little one (13 feet) – attack small boats
- Largest – Whale Shark (60 feet, 90K pounds)
3. Class Osteichthyes
   ➢ 27K bony fish
   ➢ 90% are Teleostei (Perfect bone)
     (cod, tuna, halibut, perch) – Figure 15.29
   ➢ 77 million tunas eaten
   ➢ Adaptations – camouflage, schools, speed, gas-filled swim bladders

The problems of Fishes
1. Viscosity, Shape and Propulsion
   ➢ Small ones – difficult
   ➢ Streamlined-tuna (Figure 15.30)
   ➢ Eel like movement – not as efficient (Figure 15.31)
   ➢ Fastest 75 mph
2. Maintenance of level
   ➢ Cartilaginous Fish – swim constantly (no gas bladders)
   ➢ Gas bladders – swim bladders
   ➢ Fastest fish: no swim bladders
3. Gas Exchange
   ➢ Gill membrane take in dissolved O₂
   ➢ Active fish – bigger – gill area
4. Osmotic Considerations
   ➢ Osmoregulators
   ➢ Freshwater would gain water
   ➢ Saltwater would lose water
5. Feeding and Defense
   ➢ Lateral line system – defects low frequencies
   ➢ Cryptic coloration (camouflage)
   ➢ Turbot (Fig 15.34)
   ➢ schools
   ➢ Flying Fish

Amphibians
   ➢ 2000 species exist – most are terrestrial

Marine Reptiles
   ➢ Turtles, sea snakes, marine lizards, marine crocs
   ➢ Salt glands- excrete salts from body fluids

Sea Turtles – 8 species of these
   ➢ Non retracting
   ➢ Figure 15.36 – Green one (Chelonia)
   ➢ Largest – Atlantic Leatherback (61/2 feet, 1300 lbs)
   ➢ Lay eggs on the beach they were hatched
   ➢ Ascension Island – studied there

Marine Crocs
   ➢ Mangrove swamps, reefs
   ➢ 23 feet, over a ton
Marine Birds
1. Tubenoses – Albatross (12 feet wing span, 22 lbs) (rarely flap- aerodynamic wings)
2. Pelicans – throat poaches, webbed feet
   ➢ Light delicate
3. Gulls including Terns
4. Penguins – only southern hemisphere

MARINE MAMMALS

➢ Most advanced vertebrate group – 4300 species

All marine mammals possess:
1. Streamlined Body Shape – with limbs adapted for swimming
   ➢ Drag is reduced by hair or slippery skin
2. Generate internal body heat –high metabolic rate
   ➢ No marine mammals are smaller than a sea otter (small ones would lose heat too fast)
3. Respiratory System is modified to collect and retain large quantities of \( \text{O}_2 \)
   ➢ Empty lungs completely more easily
   ➢ Could hold breath longer and utilize \( \text{O}_2 \) – whales
4. Osmotic Adaptations – skin is impervious to water
   ➢ Take in little water
   ➢ Excrete salty pee

Three main Orders:
1. Cetacea – whales, dolphins, porpoise
   ➢ Thought to have evolved from hoofed land animals related to horse/sheep
   ➢ Range in size from 1.8m (6ft) to 33m (110 ft) weigh up to 110 tons
   ➢ Nostrils at top of head

Suborders of Cetacea (Fig 15.39)
1. Odontoceti – toothed whales
   ➢ Include Orca, Dolphin, Porpoise
   ➢ High brain weight to body weight ratio
   ➢ Largest – Sperm Whale – 60 feet - dives deep (3740 ft)
     (can dive to 3740 feet)
   ➢ Search for food by echolocation (Fig 15.40)
   ➢ thought to use sound offensively as well
     ➢ Dolphins – 229 decibels
     ➢ Sperm Whales- 260 decibels
2. Mysticeti- baleen whales
   ➢ No teeth
   ➢ Eat krill (filter feed), and lots of it
   ➢ Feed close to the surface
   ➢ Blue Whale- largest – babies can grow at 9lbs per hour
   ➢ Social structure – Humpback, Bowhead
2. Order Carnivora
   a. Suborder Pinnipedia – wing foot – seals, sea lions, walrus
      - Leave ocean to mate and raise young
      - Appeared to have evolved from the same stock as modern bears
        1. Seals – covered with short coarse hair without soft under fur, no ear flaps
           - Rear appendages for swimming - not useful on land
           - Diving record – 5120 feet – elephant seal
        2. Sea Lions – have hind limbs with a greater range of motion
           (for use on land)
           - Small ears, soft under fur
           - Use front flippers for propulsion
        3. Walruses – much larger
           - 2 tons
           - dig up clams with mouths
           - use tusks for moving too
   b. Suborder Fissipedia (Split foot)
      (cats, dogs, coons, bears)
      1. Sea Otters – smallest
         - Densest and warmest fur
         - Active & cute
      2. Polar Bears – eat seals, beached whales
         - Can swim 62 miles of open water
         - 8ft tall, 1800 lbs
      3. Order Sirenia
         - Sirius -mermaid
         - Dugongs and Manatees
         - Herbivorous – (only ones)
         - Graze on sea grasses, marine algae
         - 10K world wide
         - largest (15 feet, 1500 lbs)