

Chondrichthyes

- The cartilaginous fish
- First appear in the Late Silurian
- Lost the bone of their agnathan ancestors
 - Lighter and more maneuverable
- There are two major clades...

1. Holocephali

- “whole head”---one gill opening gives their heads an undivided appearance
- Characterized by weird shape
 - fishy body but with big head and long tail
 - Big eyes and buck teeth
 - Ratfish, rabbitfish, chimera (next slide)



Characteristics

- 34 extant species
- None over 1m
- Mostly found below 80m depths
- Deposit horny 10cm eggs in shallow water
- Elaborate rostral elongations
- Continuously growing flat tooth plates
- Feed mostly on shrimp, gastropods, sea urchins

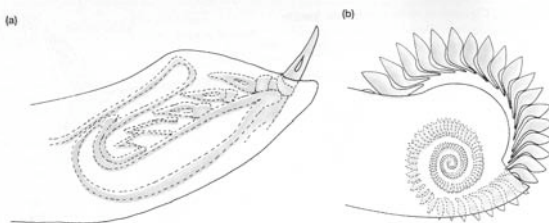


2. Elasmobranchii

- “plate gill”---multiple gill openings
 - Galeomorpha-sharks w/ anal fin
 - Sand tiger, basking
 - Squalomorpha-sharks w/o anal fin
 - Angelshark, dogfish
 - Batiodonta-skates and rays



- Paleozoic and Mesozoic sharks were identified as such by their teeth:
 - 3 cusped, little root development, dentine capped with enameloid
 - Young sharks replace teeth every 7-8 days



Extant fin arrangement and heterocercal tail in Mesozoic

The Extant Radiation

- First representatives of the extant elasmobranchs appear at least as early as the Triassic. By the Jurassic there were modern looking sharks and many of the Jurassic and Cretaceous genera are still living
- Major innovations include:
 - Overhanging snout with ventrally located mouth
 - Development of calcified vertebrae
 - Thicker and more complex tooth enamel

The Extant Groups

- There are about 360 species of sharks in two major groups
 - Squaloid
 - 80 species, more primitive
 - Galeoid
 - The dominant carnivores of species-rich regions of the oceans

cookiecutter



Hornshark, great white



General Shark Characteristics

- Consummate carnivores
- 25cm to 12-18m (typically ~2m)
- Cartilagenous vertebral centra with remnants of notochord in between which allows side to side flexing
- Neural and hemal arches above and below add extra protection to spinal cord
- Placoid scales-
 - Resemble teeth but embedded in the skin
 - Tough, flexible covering that reduces water turbulence to increase swimming efficiency

Chemoreception

Detect chemicals in concentrations as low as 1ppb



Vision

- Especially good at low light levels
- Rod-rich retina with **tapetum lucidum**
- In bright surface waters, cells containing melanin expand over that reflective surface to absorb the excess light

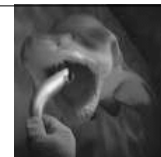


Sequential Use of Senses

- Olfaction
 - Mechanoreception
 - Vision
 - Taste?
- And if it's good....electroreception and.....



Jaws and Feeding



- **Cranial Kinesis**--mobility within the head apparatus--and the derived **Hyostylic Jaw** allow **multiple jaw positions**
- **Muscles from the lower jaw run well back onto the body so it can be pulled way down as it protrudes, increasing mouth volume**
- This sudden increase in volume also creates a big suck into the mouth

Reproduction

- Internal fertilization is universal in sharks
- Male pelvic claspers have a solid skeletal structure
- Clasper flexes 90° into the female's cloaca and is held there by various barbs, hooks, and spines until ejaculation
- In the smaller species, the male may just wrap around the female, the larger ones bite onto a fin or flank



Some Terms

- Vertebrates use some combination of the following:
 - **Lecithotrophy** (“egg nourishment”)--a yolk provides most of the nourishment for the embryo
 - **Matrotrophy** (“mother nourishment”)--embryo nourishment comes from the female's reproductive tract
 - **Oviparity**--baby hatches from egg deposited outside the mother
 - **Viviparity**--live, fully developed baby is born

There are elasmobranchs displaying each of these, and/or some combination

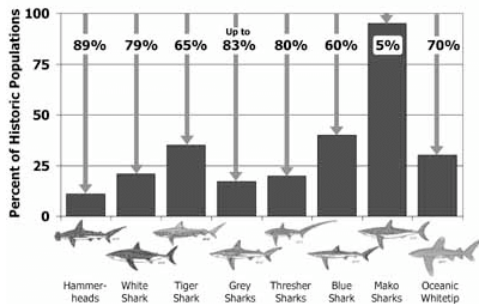
Elasmobranch Reproductive Strategies

- The elasmobranchs put their energy into fully developing just a few offspring
 - Those which are oviparous produce large eggs with large yolks, the eggs take 6-10 months to develop, the young emerge as miniature adults
 - Eggs are sometimes retained internally
 - There are a few versions of matrotrophy
 - Great white embryos feed on their siblings and other eggs in utero
 - Extensions into oviduct that secrete milky substance
 - Yolk sac placenta
- Whatever the strategy, there's no evidence of parental care



Social Behavior

- Thought to be solitary animals, but it's turning out that this may not be the case
 - Hammerheads off California seamounts
 - Basking sharks off Cape Cod
 - Dogfish in New England
 - Great Whites off South Africa



From: www.elasmo-research.org/conservation/collapse.htm

Skates and Rays

- Hypotremate (“opening below”) elasmobranchs more diverse than sharks with ~456 species
- Distinct clade that split from ancestral elasmobranch to modern sharks
- Bottom dwellers, flat plate teeth, powerful suction from protrusible mouth, electroreception
- Skates are distinguished by their thick tails with dorsal fins and caudal fin, oviparous
- Rays have whip-like tail with barbs replacing dorsal fins, viviparous

