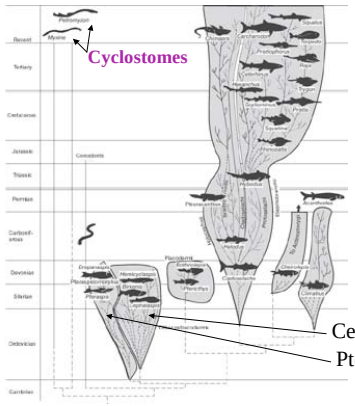
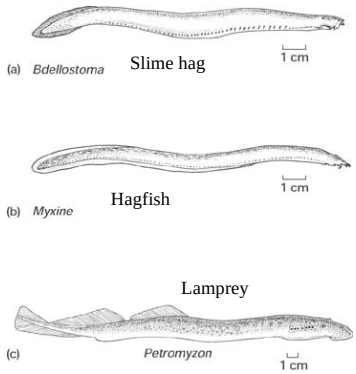
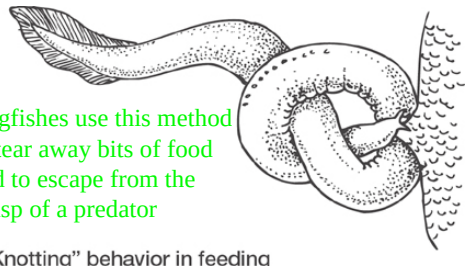


Phylogeny of Euagnathans [(= all agnathans; Ostracoderms, Pteraspidiomorpha = Diplorhina and Cephalaspidiomorpha = Monorhina) NOT a monophyletic group] and early gnathostomes



Living Agnathans

- **Cyclostomes**
  - Round mouths
  - -- Hagfishes and Lampreys
  - -- Lack bone
  - --Single nostril

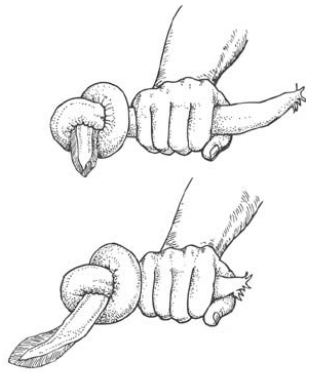


Hagfishes use this method to tear away bits of food and to escape from the grasp of a predator

e) "Knotting" behavior in feeding

The hagfish, *Myxine*

These are deepsea, mud burrowing animals



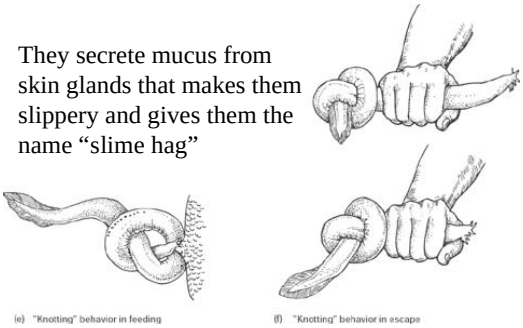
(f) "Knotting" behavior in escape

Hagfish are scavengers

They have rasping tongues with cornified "teeth" to remove flesh from prey or to help in swallowing prey

They are eel-shaped

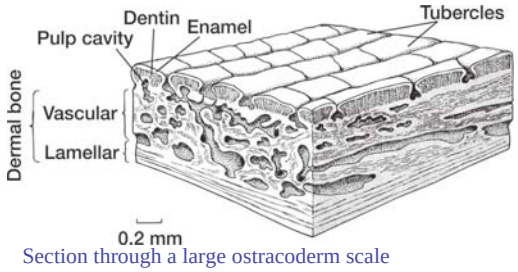
They secrete mucus from skin glands that makes them slippery and gives them the name "slime hag"



(e) "Knotting" behavior in feeding

(f) "Knotting" behavior in escape

They possess both ovaries and testes, but only one set is functional

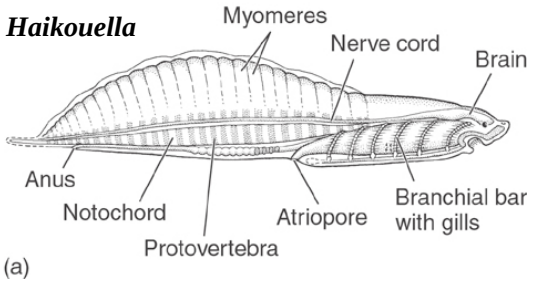


Section through a large ostracoderm scale

Raised tubercles are capped with dentin and enamel, enclosing a pulp cavity

Tubercles rest on the dermal bone armor of the body

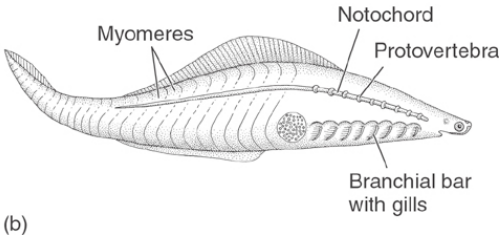
Haikouella



(a)

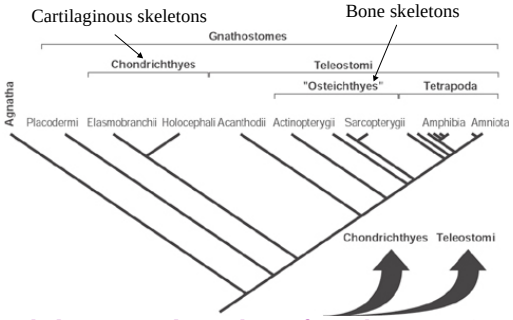
Early vertebrate – early Cambrian, Agnathan
Little specialization of head structure excludes this animal from being a craniate

Haikouicthys



(b)

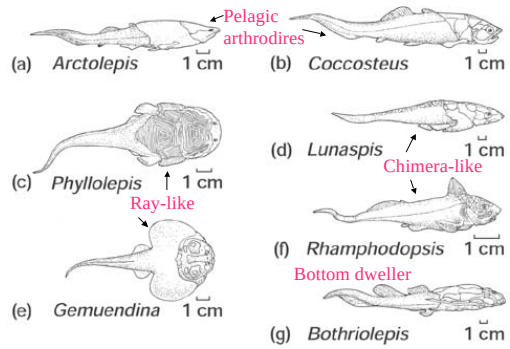
Early Vertebrate – from early Cambrian, also not a craniate but an agnathan



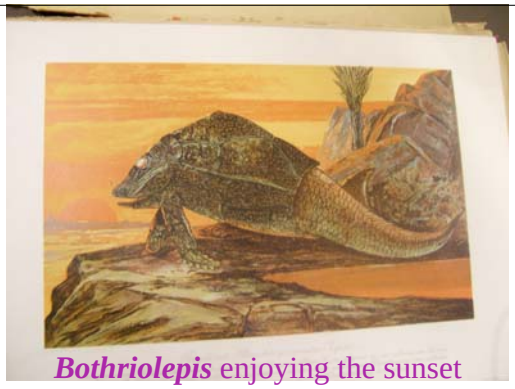
Phylogenetic relationships of Gnathostomes (= jaw mouths)

- **Gnathostome characters:**
  - Two sets of paired fins
    - Anterior = pectoral
    - Posterior = pelvic
  - Fins anchored by pectoral and pelvic girdles anchored to body wall
  - Specialized muscles controlled fin movements
  - Fins give stability and movement control of swimming maneuvers
  - Girdles could be cartilaginous or bony

- Could be active predators
- Probably had more habits and habitats available than did preceding ostracoderms
- **Two major lineages:**
  - **Condrichthyes** (cartilaginous fishes)
    - Sharks, skates and rays
  - **Teleosteomi**
    - Bony fishes
    - The most diverse vertebrate group
    - Tetrapods emerge from this group

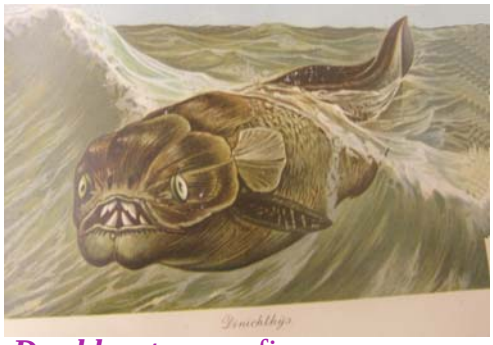


Placoderms – “plate skin” body armor, large



Bothriolepis enjoying the sunset

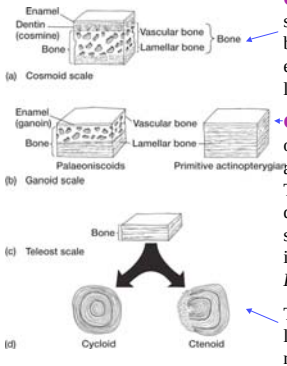
- **Placoderms** appeared in early Silurian
- Most common in Devonian
- Often had bony armor, small tails with head shields of fused bony plates
- All had jaws and paired pectoral and pelvic fins
- Notochords often also had paired neural and hemal arches
- No centrum, but arches often fused into "synarcual"
- Able to raise heads independent of vertebral column
- Maybe as large as several meters in length



Dunkleosteus surfing (arthrodire)

- Often flattened body forms = bottom dwellers
- Scavengers, probably benthic
- Some with lighter armor may have been active predators (*Dunkleosteus*)
- Some lived in salt water; others in fresh water
- Wide Devonian radiation
- Replaced ecologically by Chondrichthyes and Osteichthyes that are not closely related to them in Carboniferous
- Sadly, they left no living descendants

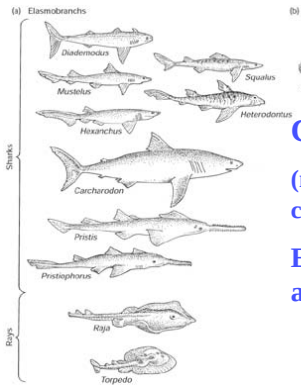
- **Placoderms** include:
  - **Rhenanids** – flattened, bottom-dwelling forms
  - **Antiarchs** and **arthrodires**, active predatory pelagic forms
  - 2/3 of the group are **arthrodires** – joint-necked fishes because of how the head shields were joined to the posterior body
  - Chimera-like form males may have had clapsers
  - Placoderms may not be a natural group



Cosmoid scales – found in sarcopterygians have a double bone layer with dentin and enamel superficial to those layers

Ganoid scales – thick surface of enamel (=ganoin) without an underlying dentin layer. The base is a double layer of dermal bone. These scales are shiny, overlapping and interlocking. Present in *Polypterus* and gars.

Teleost scales retain only lamellar bone – grow in annual rings

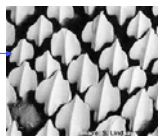


Chondrichthyes

(modern cartilaginous fishes)

Elasmobranchii and Holocephali

- **Chondrichthyes** share common characters:
  - Cartilaginous skeletons
  - Pelvic claspers in males
  - Primitive members show similar patterns of serial tooth replacement
  - Have placoid scales
    - Pointed or cone shaped
    - Show no signs of growth
    - Appear first in fossil record in Ordovician
    - Radiated in Devonian (Age of Fishes)



- Earliest Agnathans had bone so loss in Chondrichthyes must be secondary
- Some teeth and placoid scales show bone traces
- Thin bone veneer on vertebrae
- Large livers provide buoyancy
- Small numbers of young may be born alive or from eggs in leathery cases
- Cartilaginous vertebrae, not notochord
- First gill slit is reduced to a spiracle

Placoid scales of great white shark