FISH

VERTEBRATE SUCCESS IN WATER

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CONCEPTS

- Vertebrate fossils can be traced back **530 million years**
- **Hagfishes** are the most primitive vertebrates
- Aquatic environments have selected for certain adaptations in fishes. These include;
  - Abilities to move in a relatively dense medium
  - Exchange of gases with water or air
  - Regulation of buoyancy
  - Detection of environmental changes
  - Regulation of electrolytes (ions) and water in tissues
  - Successful reproduction

- Fishes have been traditionally divided into two superclasses
  1. **Agnathans** (Jawless fish with paired appendages)
     - Extinct ostracoderms
     - Lampreys
     - Hagfishes
  2. **Gnathostomata** (Jawed fish)
     - Cartilaginous fish (class Chondrichthyes)
     - Bony fish (class Osteichthyes)
- Adaptive radiation resulted in the large variety of fishes present today
- Evolution of some fishes led to the terrestrial vertebrates

PHYLOGENETIC RELATIONSHIPS

- Fishes are members of the chordate subphylum Vertebrata
- Fish have vertebrae that surround their spinal cord and provide the primary axial support
- They also have a skull that protects the brain

EVOLUTION OF FISHES

- The first vertebrates were probably **marine**, because ancient stocks of other **deuterostome phyla** were all marine
- They possessed neither jaws nor paired appendages
- However, the evolution of fishes resulted in both jaws and paired appendages as well as many other structures
- Vertebrates, however, adapted to **freshwater** very early, and much of the evolution of fishes occurred there

- The majority of the evolutionary history of some fishes took place in **ancient seas**
- However, most of the evolutionary history of others occurred in **freshwater**
- Over 41% of all fish species are found in freshwater, even though freshwater habitats represent only a small percentage (0.0093% by volume) of the earth's water resources

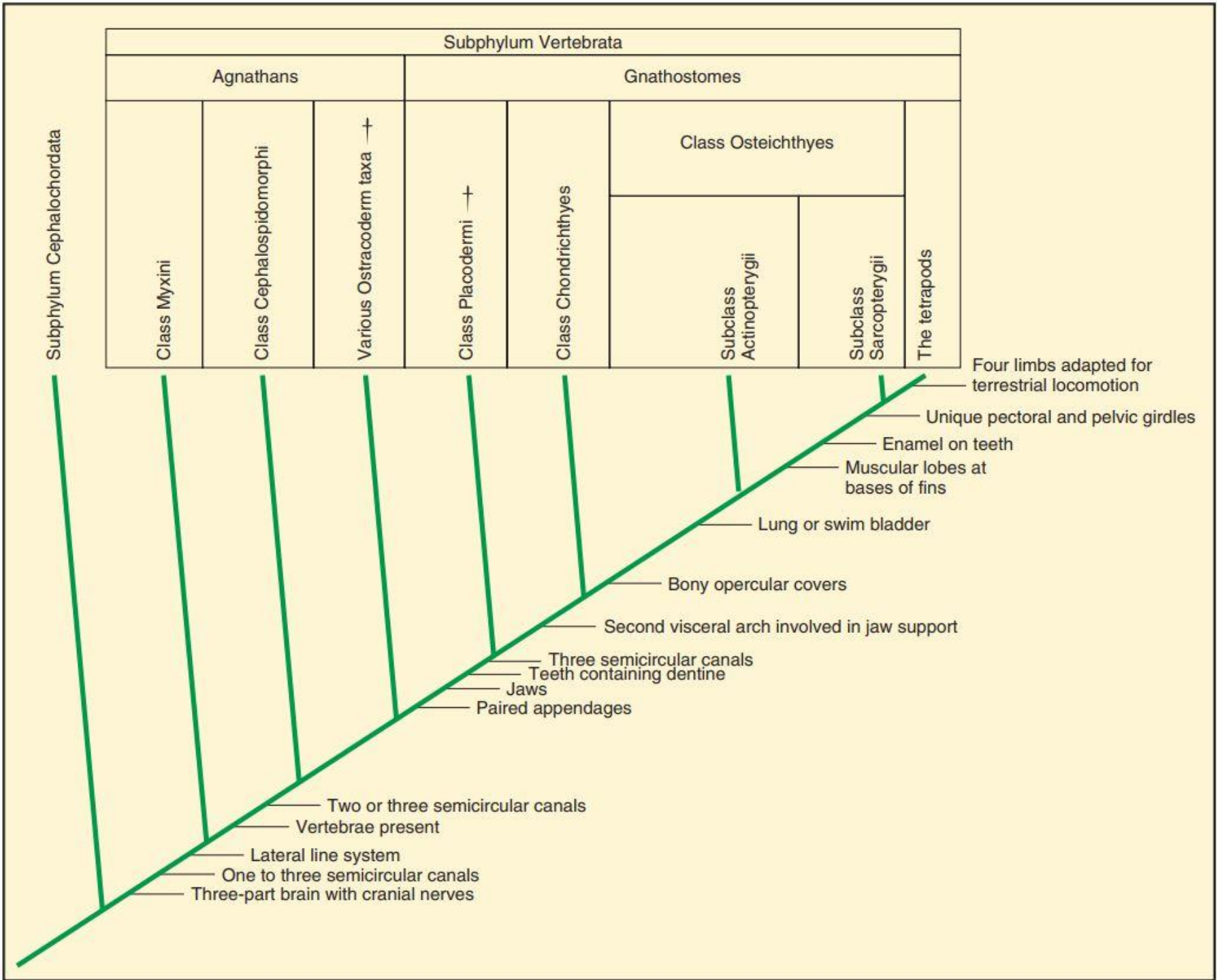

Figure 1: Phylogeny of Fishes

This cladogram shows few selected ancestral and derived characters. Recent evidence indicates that both lampreys and ostracoderms are more closely related to jawed vertebrates than to hagfishes.

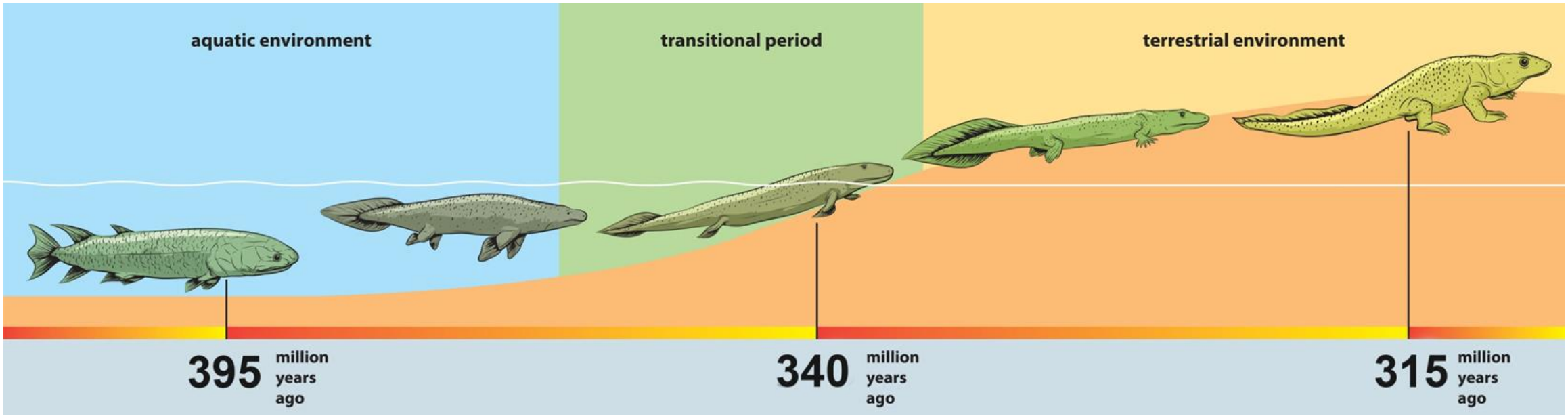

Figure 2: Evolution of Fish

TAXONOMY OF FISHES

- Fishes have been divided into superclasses based on whether they
  - Lack jaws and paired appendages (**Agnathans**) or
  - Possess jaws and paired appendages (**Gnathostomes**)

- Some members of the Agnathans (lampreys and some ostracoderms) are more closely related to jawed fishes (gnathostomes) than to other agnathans (hagfishes)

VS

Lamprey

Coccosteus

Figure 3: Agnathans and Gnathostomes

TABLE 18.1
CLASSIFICATION OF LIVING FISHES

Subphylum Vertebrata (ver″te-bra′tah)

"Agnathans" (ag-nath′ans)

Lack jaws and paired appendages; cartilaginous skeleton; persistent notochord; two semicircular canals. (Hagfishes have one semicircular canal that may represent a fusion of two canals.)

Class Myxini (mik′sĭ-ne)

Mouth with four pairs of tentacles; olfactory sacs open to mouth cavity; 5 to 15 pairs of pharyngeal slits. Hagfishes.

Class Cephalaspidomorphi (sef″-ah-las″pe-do-morf′e)

Sucking mouth with teeth and rasping tongue; seven pairs of pharyngeal slits; blind olfactory sacs. Lampreys.

"Gnathostomes" (na′tho-stomes″)

Hinged jaws and paired appendages; vertebral column may have replaced notochord; three semicircular canals.

Class Chondrichthyes (kon-drik′thi-es)

Tail fin with large upper lobe (heterocercal tail); cartilaginous skeleton; lack opercula and a swim bladder or lungs. Sharks, skates, rays, ratfishes.

Subclass Elasmobranchii (e-laz″mo-bran′ke-i)

Cartilaginous skeleton may be partially ossified; placoid scales or no scales. Sharks, skates, rays.

Subclass Holocephali (hol″o-sef′a-li)

Operculum covers pharyngeal slits; lack scales; teeth modified into crushing plates; lateral-line receptors in an open groove. Ratfishes.

Class Osteichthyes (os″-te-ik′-the-es)

Most with bony skeleton; operculum covers single gill opening; pneumatic sacs function as lungs or swim bladders. Bony fishes.

Subclass Sarcopterygii (sar-kop-te-rij′e-i)

Paired fins with muscular lobes; pneumatic sacs function as lungs. Lungfishes and coelacanths (lobe-finned fishes).

Subclass Actinopterygii (ak″tin-op′te-rig-e-i)

Paired fins supported by dermal rays; basal portions of paired fins not especially muscular; tail fin with approximately equal upper and lower lobes (homocercal tail); blind olfactory sacs. Ray-finned fishes.

Figure 4: Classification of Fish

AGNATHANS

OSTRACODERMS

- Ostracoderms are **extinct agnathans** that belonged to several classes
- The ostracoderms were **sluggish**
- Their **bony armor** was their only defense
- Ostracoderms were **bottom dwellers**, often about 15 cm long
- Most were probably **filter feeders**
- Or extracting annelids and other animals from muddy sediments
- Some ostracoderms may have used **bony plates around the mouth** in a **jawlike fashion** to crack gastropod shells or the exoskeletons of arthropods

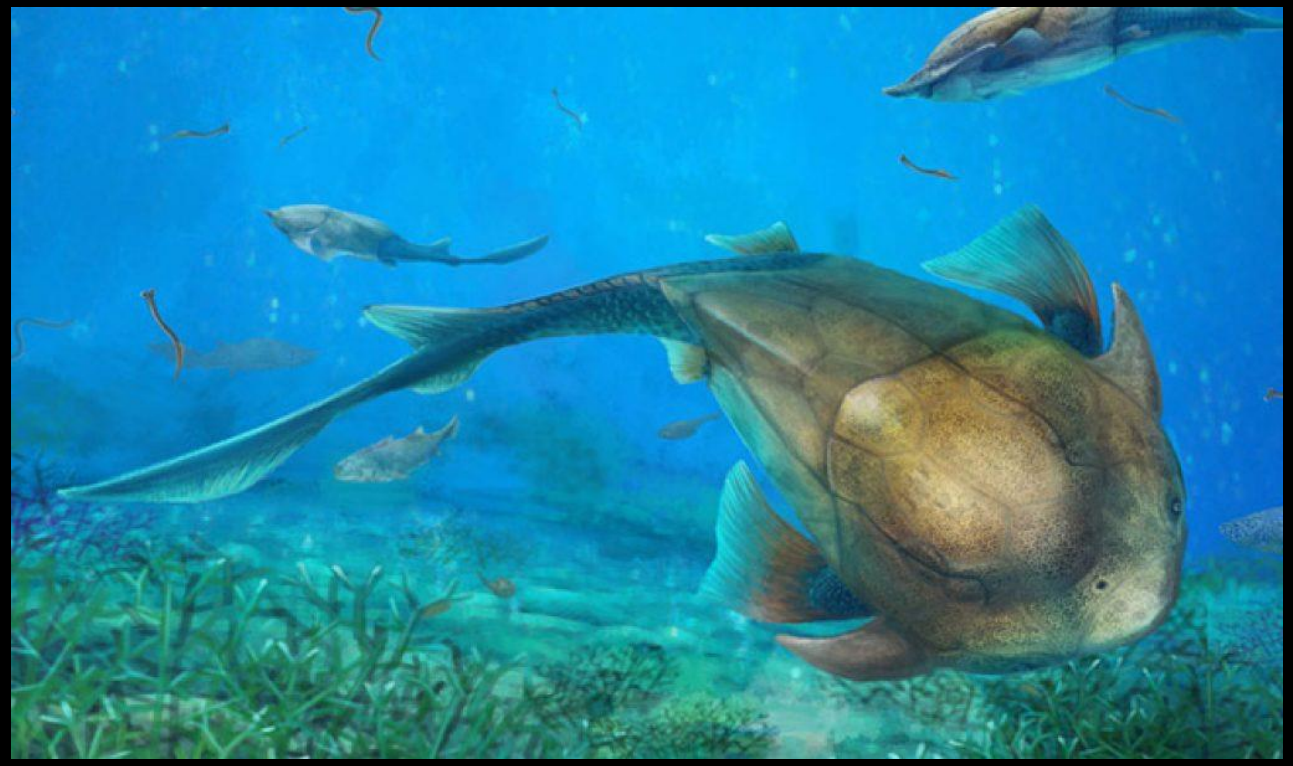

Figure 5: Ostracoderms

CLASS MYXINI

- Hagfishes are members of the class Myxini
- Hagfishes **live buried** in the sand and mud of marine environments
- They feed on soft-bodied invertebrates and scavenge dead and dying fish
- The hagfishes have **excessively slimy bodies**
- Most zoologists consider the hagfishes to be the **most primitive** group of vertebrates

When hagfishes find a suitable fish, they enter the fish through the mouth and eat the contents of the body, leaving only a sack of skin and bones

Figure 6: Hagfish feeding on a shark

CLASS CEPHALASPIDOMORPHI

- Lampreys are agnathans in the class Cephalaspidomorphi
- They are common inhabitants of marine and freshwater environments in temperate regions
- Most adult lampreys prey on other fishes, and the larvae are filter feeders
- The mouth of an adult is suckerlike and surrounded by lips that have sensory and attachment functions
- Numerous epidermal teeth line the mouth and cover a movable tonguelike structure
- Adults attach to prey with their lips and teeth and use their tongues to rasp away scales
- Lampreys have salivary glands with anticoagulant secretions and feed mainly on the blood of their prey
- Some lampreys, however, are not predatory.
- Members of the genus Lampetra are called brook lampreys
- The larval stages of brook lampreys last for about three years, and the adults neither feed nor leave their stream
- They reproduce soon after metamorphosis and then die