

Fishes



Lukáš Kalous

What is fish?

- According to Nelson:
- Vertebrate that lives in the water breathing with gills with limbs in the shape of fins
- Some scientists add:
 - Poikilothermic (cold blooded) animals
 - Body is mainly covered with scales

Is it fish?

YES



NO

Is it fish?

YES



Is it fish?

YES



NO

Is it fish?

NO



Is it fish?

YES



NO

Is it fish?

YES



Is it fish?

YES



NO

Is it fish?

YES



Is it fish?

YES



NO

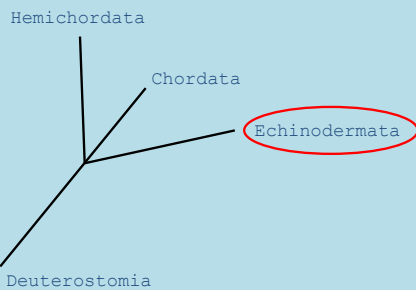
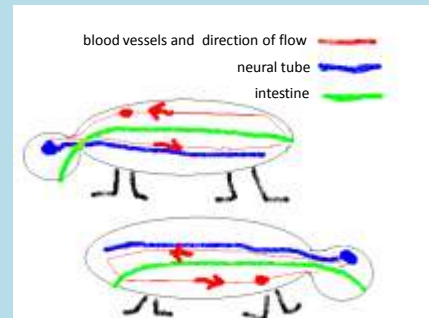
Is it fish?

Difficult to judge



Deuterostomia

- the first opening (the blastopore) becomes the anus
- Nerve cord is situated in the back
- Uniform origin of coelomu



Echinodermata Echinoderms

- benthic zones of sea
- Calcareous skeleton
- Pelagic larvae
- Adults - radial symmetry
- Calcareous spines



- **Crinoids**
(Crinoidea)



- **Sea stars**
(Asteroidea)



- **Ophiuroids**
(Ophiuroidea)

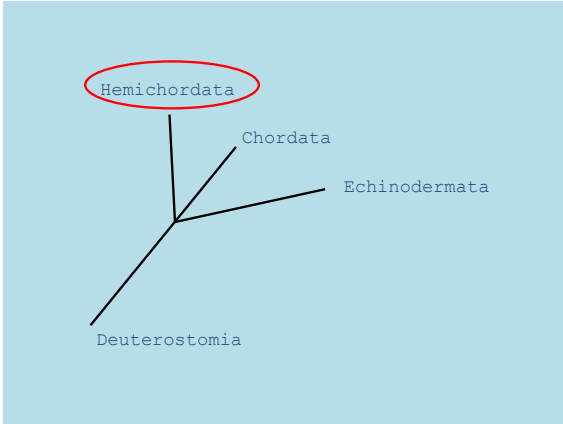


- **Sea urchins**
(Echinoidea)



- **Sea cucumbers**
(Holothuroidea)

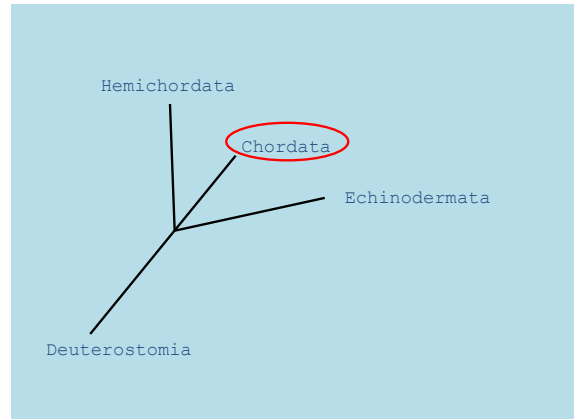
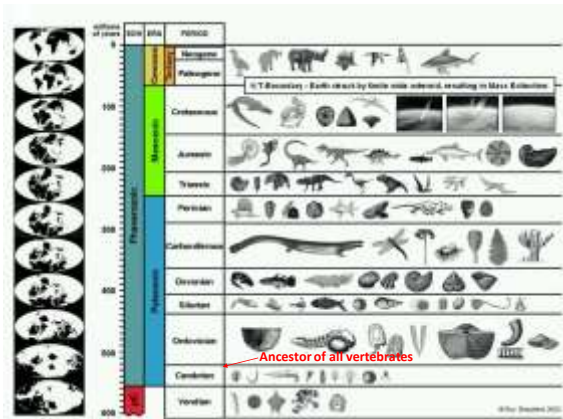




Hemichordata

- Up to 30 cm
- Sea bad
- gonochorists
- Dig in the bottom, or sedentary colonies
- Pharynx is modified for filtration - food
- Pharyngeal slits, Gill openings

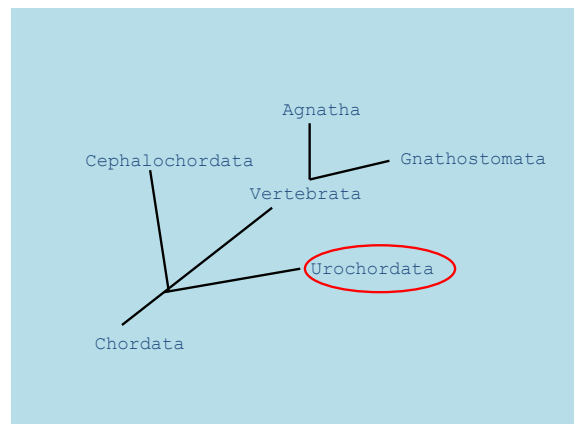
A detailed line drawing of a sea slug, showing its body, pharynx, and several pairs of gill openings (pharyngeal slits) extending from the pharynx.



Chordata Chordates

At least in embryos

A diagram of a chordate embryo with labels for various features: Notochord, Dorsal hollow nerve cord, Brain, Mouth, Pharyngeal slits, Anus, Postanal tail, and Muscular segments. Text boxes describe these features: '1. Notochord - long flexible rod of transverse fibers found in all chordates; in vertebrates replaced by vertebrae of backbone', '2. Muscular segments', '3. ectodermal tissue that forms a neural cord', '4. subpharyngeal feeding structure in invertebrates; gas exchange in aquatic vertebrates & jaws & hearing in vertebrates', and '5. mouth & pharynx elements provide propulsive force'.



Urochordata Tunicates

- Single layer skin
- Pharynx is modified for filtration - food
- Characters of chordates are present in larvae
- Sea squirts (Ascidiacea)
- Salps (Thaliacea)
- Appendicularia (Larvacea)

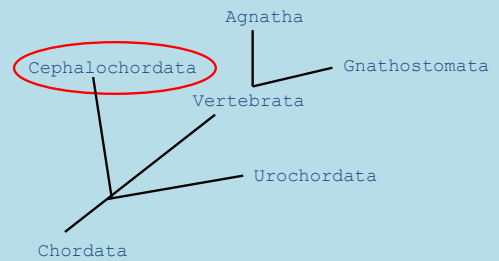
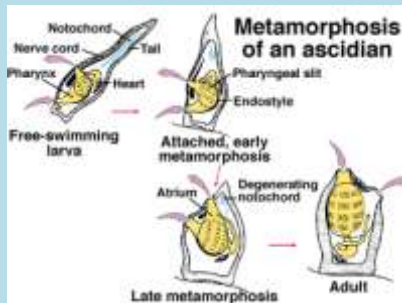


Ascidiacea - Sea squirts

- sea
- extracorporeal fertilization
- filtration
- proterandric (at first)
- Larvae shortly swims

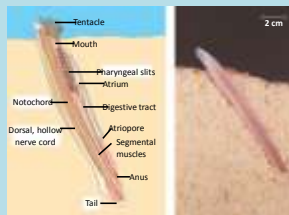


Halocynthia papillosa



Cephalochordata

- One layer skin
- pharynx
- Nerve system equal to vertebrates
- Lack of brain
- Closed vascular system
- Head and tail end
- muscle Metamerism

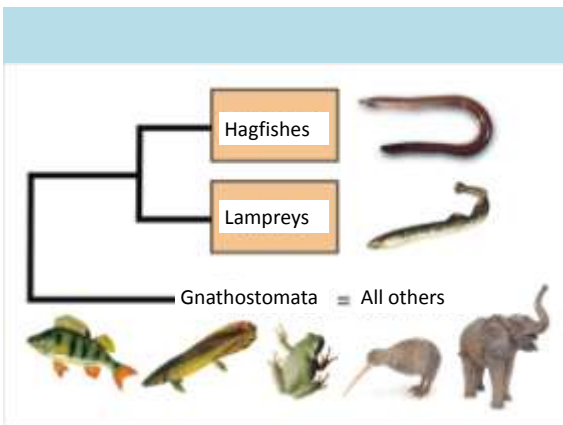
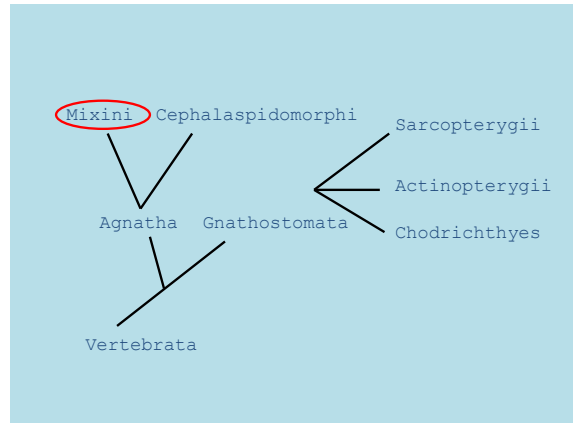
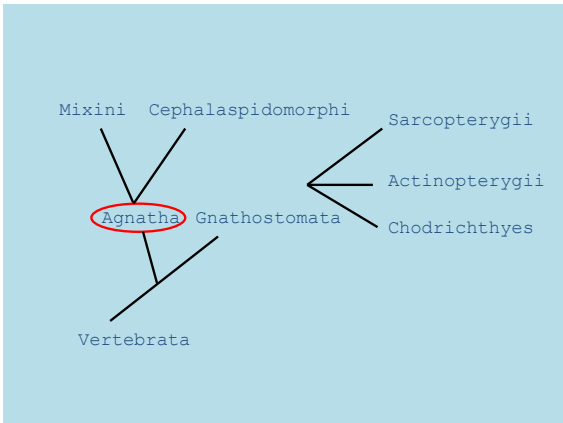
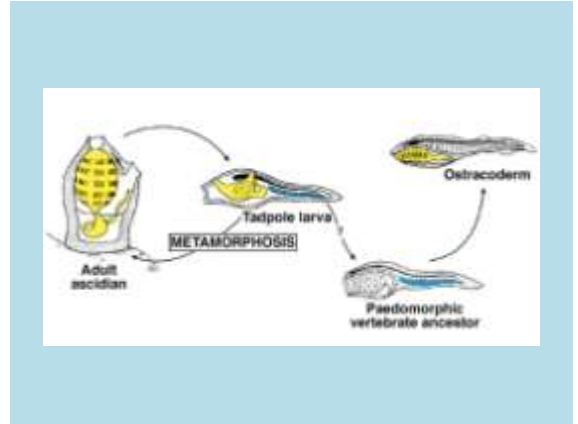
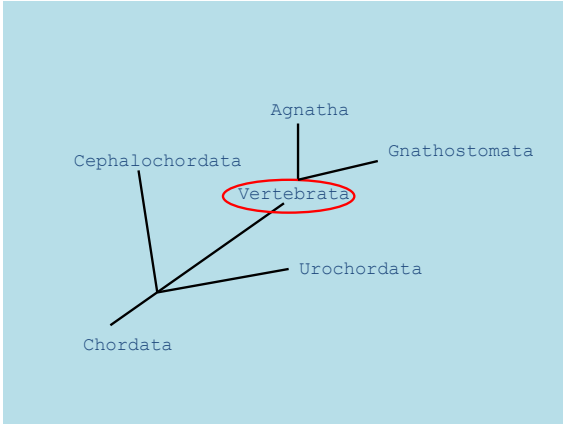


Amphioxi lancelets

Branchiostoma lanceolatum →



- Sea
- length 5-6 cm
- Bilateral symmetric
- Feed filtration, detritus, diatoms
- Littoral 10-50 m
- During the day buried in the bottom night activity

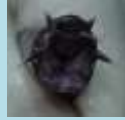


What share all vertebrates:

- Pair of Eyes
Tissue arising from the neural crest
Muscle power branchial apparatus (no longer filtration with CILIA (CIRRI)!)

Myxini hagfishes

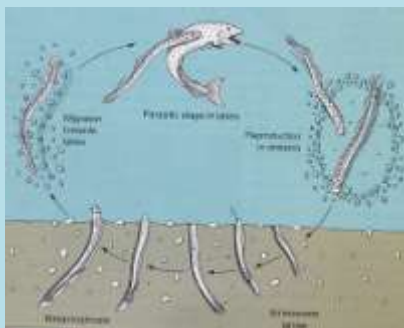
- Mouth stellate
- Tentaculs
- ceratinous teeth on tongue
- Large mucus glands
- predators (marine invertebrates), nekrofags (dead, wounded fish)
- through gill-cover can penetrate into the fish



Hagfishes – simple body plan(parasitism)

Cephalaspidomorphi lampreys

- 7 pairs of branchial openings
- cartilaginous skeleton
- Adults do not eat at all or suck the blood
- Fin hem at the back of the body



Brook lamprey-*Lampetra planeri*

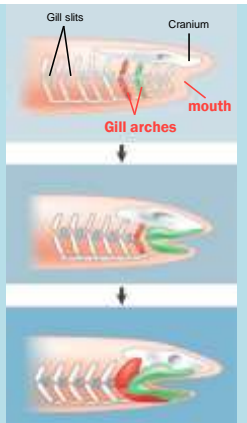
Ordo: Petromyzontiformes

Family: Petromyzotidae



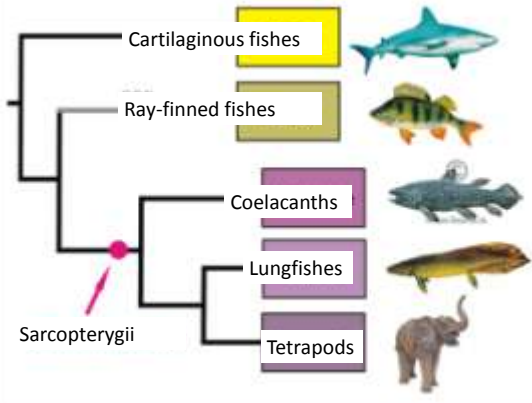
Gnathostomata

- Emergence of the jaw - one of the most useful adaptation!



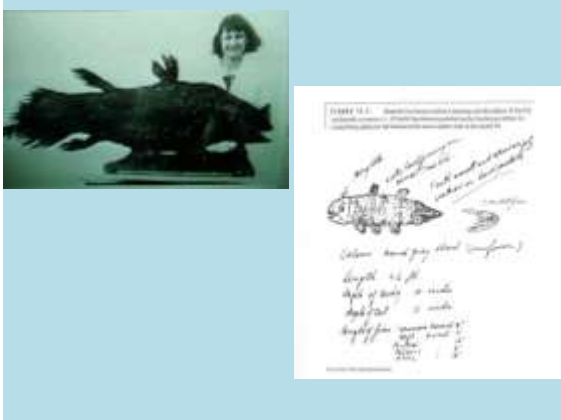
Evolutionary innovations of Gnathostomata:
Adaptation of vertebrates

- Jaws
- 7 branchial arches (gradual transformation of the jaw, hyoid bone, etc.)
- Two pairs of fins => from them, then limb



Coelacanthimorpha
Coelacanth

- Already known from the Palaeozoic
- Recently 2 species of strange living fossils Latimeria (*Latimeria chalumnae*, *L. menadoensis*)
- 22/12/1938 discovered, the Museum of East London
- M. Courteny-Latimer
- First exemplar rot
- Should have disappeared before 70 miles.
- Second catch after 24.12.1952 in the marketplace,
- Comoros Islands



Latimeria

- Coelacanth is derivate from ancestors (after all only survived until today ...)
- Ovoviviparity, gas bladder filled with oil, muscle penholder on unpaired limbs (legs, fins ...)

- ovoviviparous
- Offspring - „endouterine“ cannibalism
- => unique way of swimming! Right pectoral fin with left ventral fin and vice versa

Where live Latimerias

- Depth of approx. 200 m

Comoro islands

First catch of Latimeria - closed to estuary of the River Chalumna

Latimeria menadoensis

- In September 1997, Mark Erdmann PhD student of biology,
- North Sulawesi (Celebes)
- E. Balon image appeared on their honey moon site
- later the image serve for description of a new species *Latimeria menadoensis*

Occurrence of Latimerias today

> 10.000 km

Mozambique Current

Equatorial Current

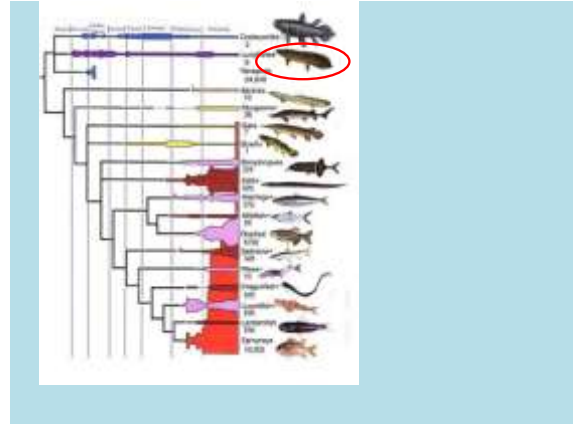
1938, 1992, 1995, 1998

コモロ (Comoro)

インドネシア (Indonesia)

○ *Latimeria chalumnae*

● *Latimeria menadoensis*



What are lungfishes?

- Also called Dipnoi
- Africa, America and Australia

What are lungfishes?

2 „lungs“ Filamentous fins AFR

AME

1 „lung“ muscle penholders AUS

Longirostris, a. *Protopterus antiopeus*, b. *Lepidosiren paucidens*, c. *Neoceratodus forsteri*.



Adaptation of Dipnoi, Lungfishes

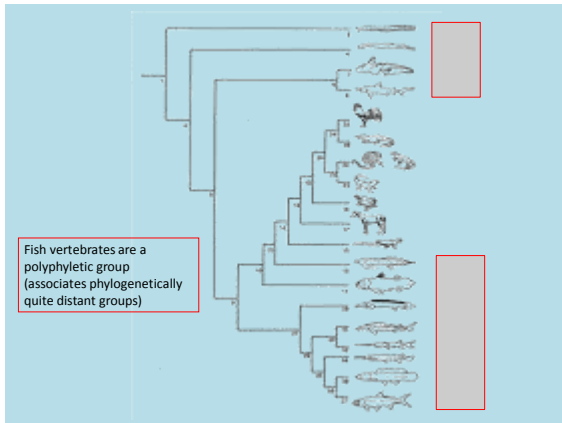
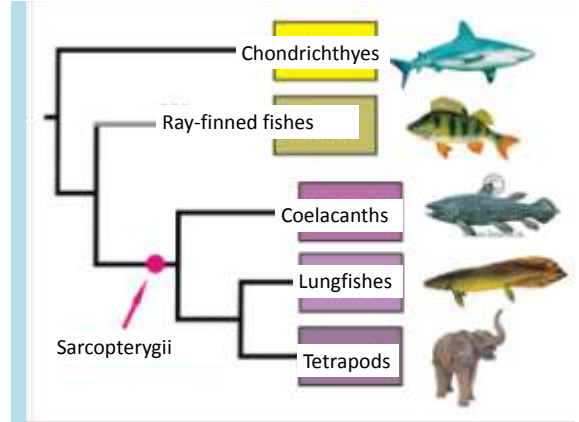
- Dry periods, drying of water, low oxygen content in water

- Lungs
- Ability to aestivate
- Cocoon! (x AUS)
- External gills (x AUS)

Another interesting and unique features:

- Large quantities of DNA

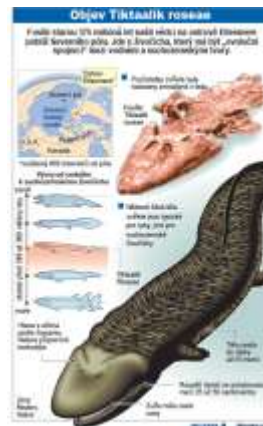
Dipnoi were considered to be ancestors of amphibians!



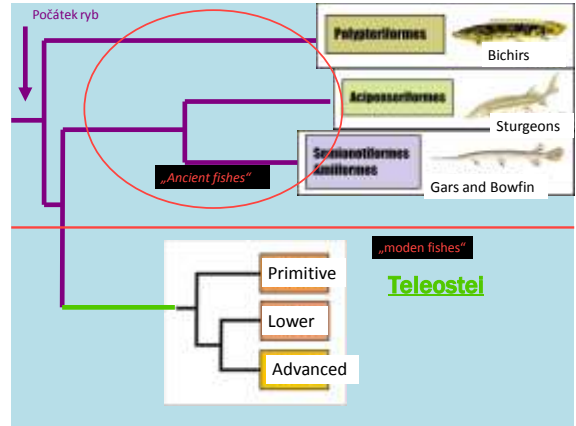
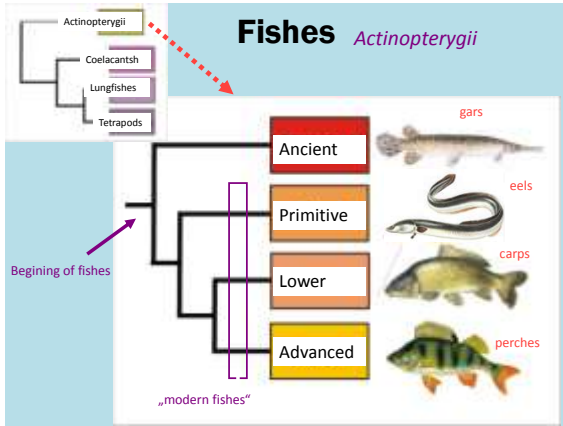
Who was first tetrapod?

- The first is a quadruped animal, discovered recently. His name is

Tiktaalik!

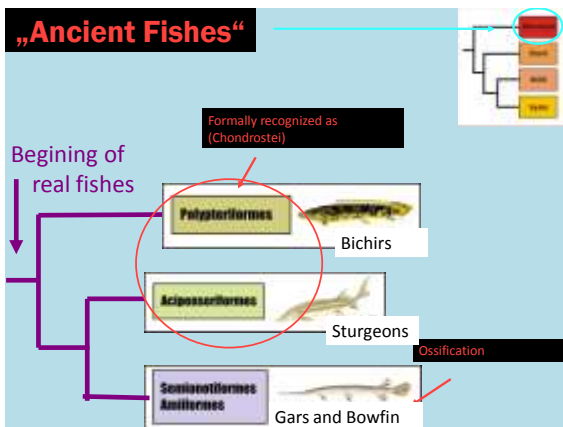


- 75 million years
- North Pole / Canada
- Dry: Place the head, thick ribs, neck, wrist
- Water: scales, fins, a primitive jaw



Bichirs

- They have muscular penholder on fins
- Pair of lungs
- external gills
- => All similar to dipnoi!
- ganoid fish scales



„Ancient Fishes“

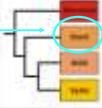
Sturgeons

Bowfin


Gars

- „Ancient fish“ have a lot of „primitive“ characters, which they share with other animals - such as the lungfish and amphibians (spiral algae in the gut, the types of vertebrae) These more advanced features disappeared in the so-called „modern fish“


„modern fishes“ - primitive




Arowana



Herrings



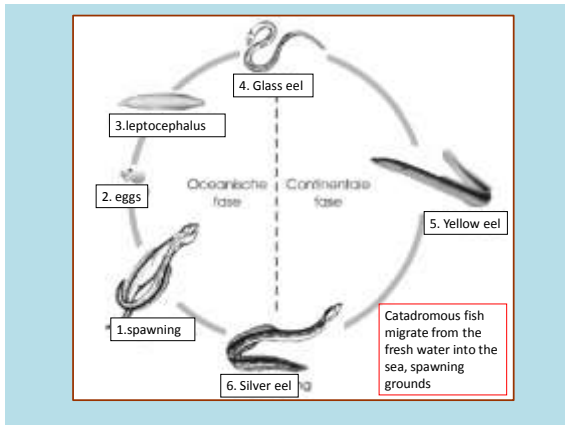
Eels



European eel - *Anquilla anquilla*

ordo: *Anquilliformes*
family: *Anquillidae*

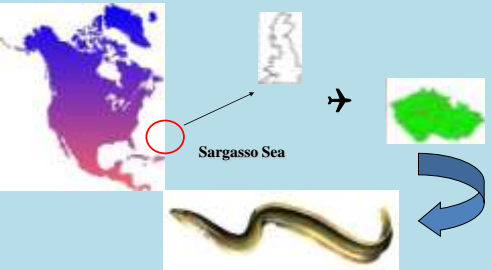





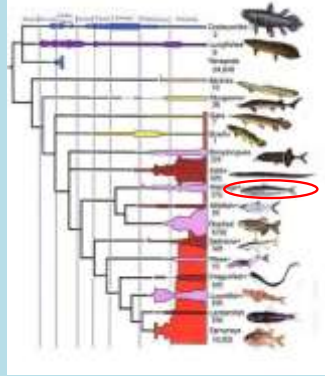



Leptocephalus

Catadromous migration



Sargasso Sea

Clupeids - Clupeiformes

Herring *Clupea harengus*

ordo: *Clupeiformes*
family: *Clupeidae* 2,4 Mt



Sardine *Sardina pilchardus*

Řád: *Clupeiformes*-bezostní
Čeleď: *Clupeidae*-sled'oviti 2,4 Mt



Anchovy (*Engraulis rigens*)

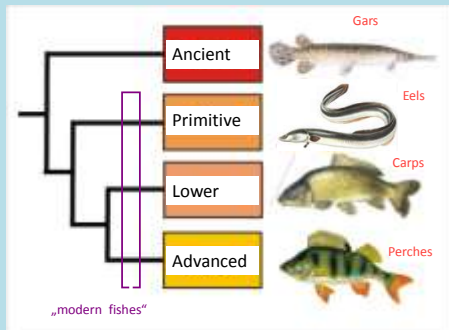
ordo: *Clupeiformes*-bezostní
family: *Clupeidae*-sled'oviti



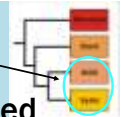
Fishing



Fishes *Teleostei*



„modern fishes“

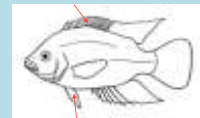
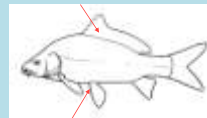


lower

enhanced

- Few spines in fins
- Gas bladder associated with the esophagus (physostomes-ductus pneumaticus)
- Pectoral and pelvic fins position

- Number of spines in fins
- Gas bladder not associated with esophagus - (physoclists)
- Pelvic fins at the throat



„modern fishes“ - lower

salmons

catfishes

carps

pikes

OSTARIOPHYSI

- dominant group (75% freshwater fishes, 27% all fishes)
- distribution- whole world except Australia and Antarctica

5 ordi:

- Gonorhynchiformes
- Cypriniformes
- Characiformes
- Siluriformes
- Gymnotiformes

Synapomorphy=shared derived characters

- Weber apparatus first 5 vertebrae
- interconnection of the inner ear and swim bladder

OSTAR = small bone
Physsa = bladder

alarm
- Alarm pheromone (schreckstoff *) - in the spec. dermal cells
alarm reaction to the presence in water

ř. Characiformes (characiforms)

- distribution: tropical waters,
- center - Neotropical region (S and C America), Africa (2 groups: Citharinidae, Alestiinae)
- Anatomically and ecologically very diverse group
- Toothed jaws (kaprovití not!) - většina druhů má tukovou ploutvičku

- 10? families, min. 1 500 species

- A popular aquarium fish
- Cycloid or ktenoid scales (Gymnocharacinus bergi - no)

Hydrocynus goliath
140 cm

Paracheirodon axelrodi
Neon tetra
family Characidae

Serrasalminae (PIRANAS)

- 13 genus, ca.60 species
- Predatory genera:
Serrasalmus
Pygocentrus
Hydrolycus
- Phytophagous genera:
Myleus
Metynnis – „silver dollars“
Colossoma – „pacus“

Pygocentrus nattereri
piranas

Skull of the species
Serrasalmus elongatus

Metynnis sp.

Siluriformes catfishes

- huge group: 34 families, ca. 2 855 kinds
- distribution: fresh to brackish water on all continents (Antarctica in the Oligocene), the largest diversity in S. America

Pangasius gigas
3 m, Mekong

- majority benthic, often predators, parasites (Vandellia)
- bone plates, adipose fin, the first ray of P and D are often forced, sometimes poison gland
- usually 4 pairs of barbels, massive bone head
- Weber's well-developed apparatus
- fishing and aquarium fish

Candirú (Vandellia)

<http://www.youtube.com/watch?v=QQWgUht-ObI>

Clarias gariepinus



Ictalurus nebulosus



Wels *Silurus glanis*

ordo: *Siluriformes*

family: *Siluridae*



Distribution of Cypriniformes

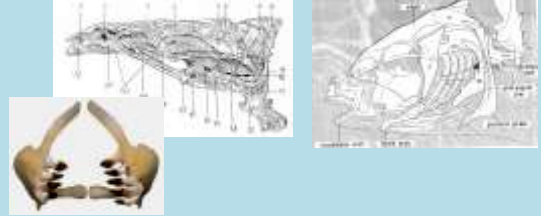
Diversity of the group:
 7 Families
 280 genera
 cca 3 285 species
 cca 2 600 undescribed?



characters

- Weber apparatus
- protractil mouth - premaxilare connected with kranium by ligament
- Jaws toothless
- pharyngeal teeth – 5. gill arch- taxonomy
- usually swimm bladder is divided to 2 parts
- connected with intestine (*ductus pneumaticus*) – PHYSOSTOMI

Spawning tubercles



Carassius auratus



fytophyloous

Cyprinus carpio



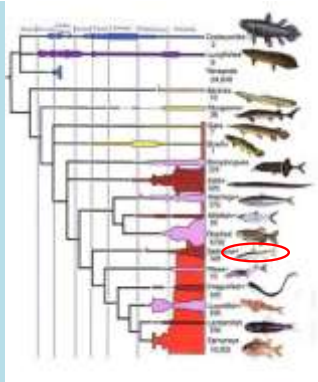
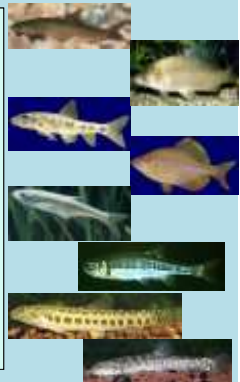
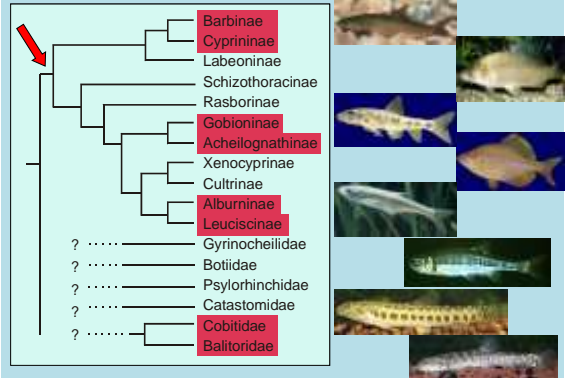
Phytophyloous

Rhodeus amarus



ostrakophyloous

Cypriniforms in Central Europe



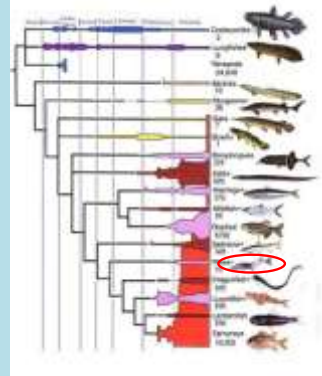
Salmonids - Salmoniformes

Salmon is anadromous fish



- Inprinting
- Movements
- Aquaculture
- Project of reintroduction

Salmon and trout



Esociformes

Pike-Esox lucius

Ordo: *Esociformes*
Family: *Esocidae*



„modern fishes“ - enhanced

Deep sea fishes

tetraodonts

cods

perches

Cod fish-*Gadus morhua*

Ordo: *Gadiformes*

Family: *Gadidae*



Consumption of fish per head



Burbot-*Lota lota*

Ordo: *Gadiformes*

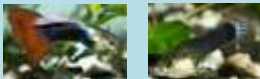
Family: *Gadidae*



Merluccius merluccius

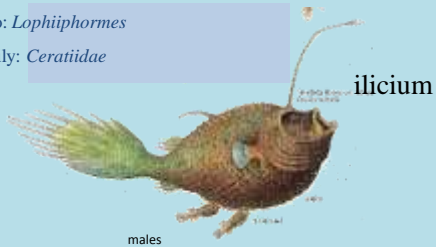


Belone belone ordo Beloniformes



Poecilia reticulata, Poeciliidae, Cyprinodontiformes



*Ceratias holboelli*Ordo: *Lophiiformes*Family: *Ceratiidae**Gasterosteus aculeatus*Ordo: *Gasterosteiformes-volnoostni*Family: *Gasterosteidae-koljuškoviti**Hypocampus sp.*Ordo: *Gasterosteiformes*Family: *Syngnathidae*Scorpion fish-*Scorpaena scrofa*Ordo: *Scorpaeniformes*Family: *Scorpaenidae**Bullhead Cottus gobio*Ordo: *Scorpaeniformes*Family: *Cottidae*

Perciforms (Perciformes)

- Double dorsal fin
- Front of dorsal fin rays with spines
- Ktenoid scales
- Gas bladder is connected with the esophagus
- Largest order of vertebrates (6900 species)
- Quarters of global fish catches
number of families: for example Mackerels, perches, cichlids

European perch *Perca fluviatilis*

Ordo: *Perciformes*
 Family: *Percidae*



Tuna Tuna sp.

Ordo: *Perciformes-ostnoploutvi*
 Family: *Scombridae-Makreloviti*



Macrel *Scomber scombrus*

Ordo: *Perciformes*
 Family: *Scombridae*



Lates niloticus – Nile perch in Lake Victoria



Sea bass (*Dicentrarchus labrax*)
 Sea bream (*Sparus aurata*) -
 Aquaculture

- Freshwater, brakish water
- America, Africa, Asia
- Interrupt lateral line
- One dorsal fin
- Moth breedrs,
- Cichlidae -Cichlids



Pterophyllum altum



Cichlidae - Nile tilapia (*Oreochromis niloticus*)
 important species in aquaculture



Symbiotic relation with anemone lives *Amphiprion ocellaris*,
 Pomacentridae

Gobids *Gobiidae*

- Fresh and salt water tropics and subtropics
- Ventral fins are sucking discs
- Climbers (*Periophthalmus* spp.)
- Without water lasts several days
- Eyes on the surface - see the land
- Mangroves



Flat fishes Pleuronectiformes

- Adult-slim body without bilateral symmetry
- from eggs to larva symmetrical
- body gradually begins to move one eye to another,
- the body flattens



Takifugu vermicularis

Ordo: *Tetraodontiformes* - četverzubci

Family: *Tetraodontidae* - četverzucoviti

