

TELOEOSTEI = OSTEOGLOSS +
ELOPOMORPHA + CLUPEOMORPHA
+ EUTELEOSTEI

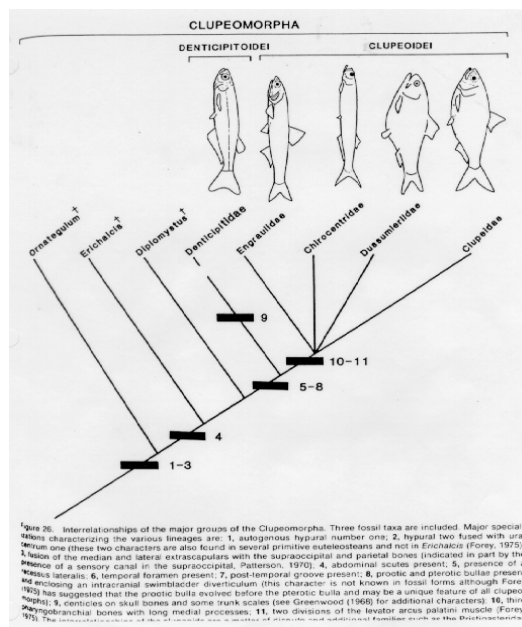
EUTELEOSTEI = OSTARIOPHYSI +
PROTACANTHOPPTERYGII +
NEOTELEOSTS

NEOTELEOSTS = 3 groups +
ACANTHOMORPHA

ACANTHOMORPHA = 3 groups +
Acanthopterygii

ACANTHOPTERYGII = Mugilomorpha
+ Atherinomorpha + Percomorpha

Review - Clupeomorpha



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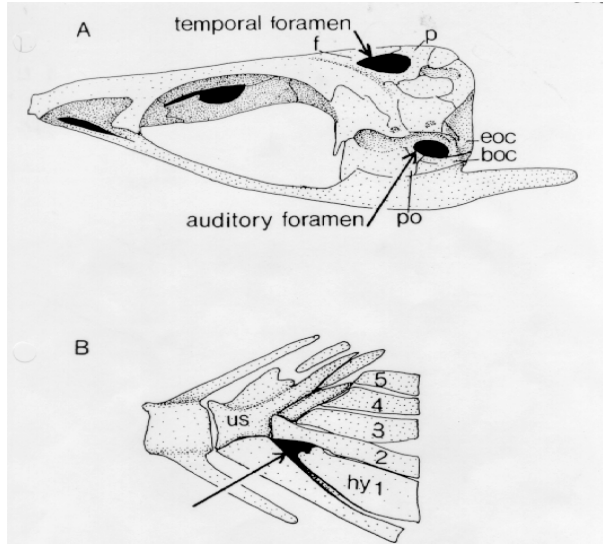
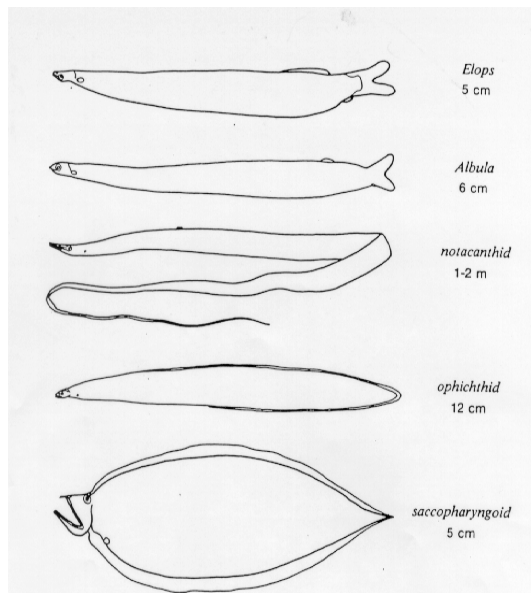


Figure 25. A. Lateral view of a clupeomorph neurocranium, showing the temporal and auditory foramina, surrounded respectively by the frontal (f) and parietal (p) bones, and by the prootic (po), basioccipital (boc) and exoccipital (eoc). B. Lateral view of a clupeomorph caudal skeleton showing the gap between the "urostyle" (us) and the first hyal (hy 1).

Review - Elopomorph



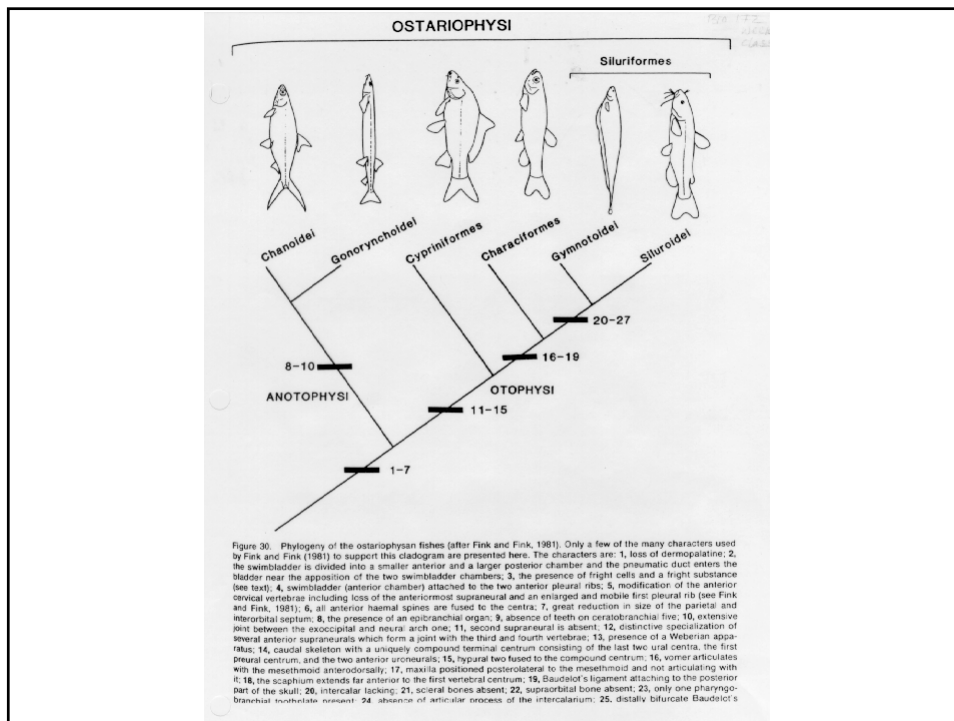
Representatives of some elopomorph leptocephali larvae. Typical maximum length given.

Ostariophysii

Monophyly = the Ostariophysii - huge and tremendously important assemblage

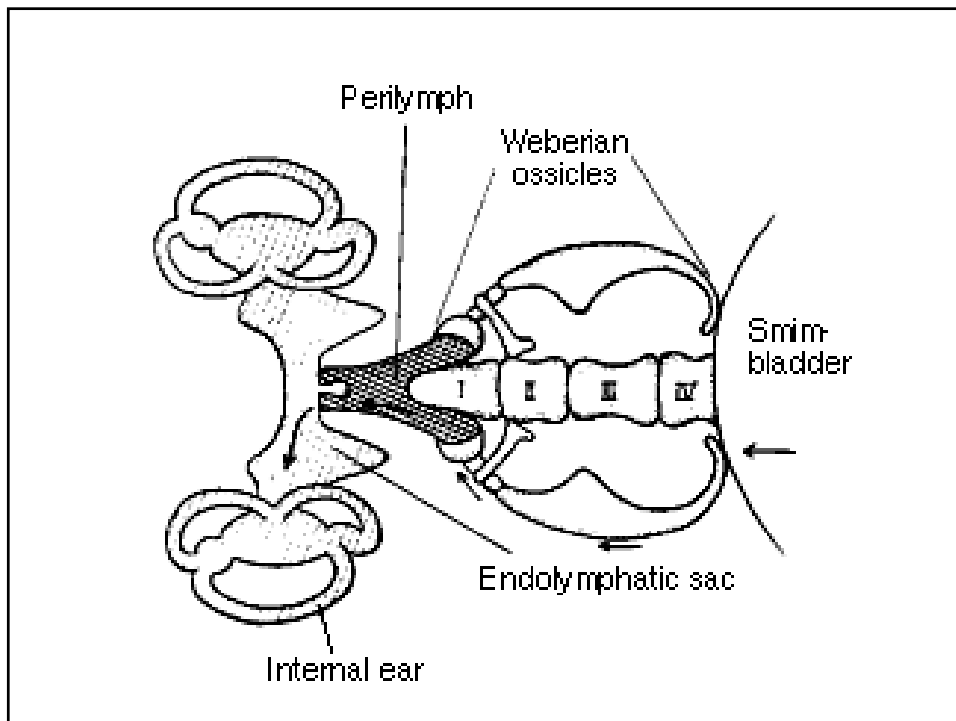
Roughly three of four fish species in freshwater belongs to ostariophysii.

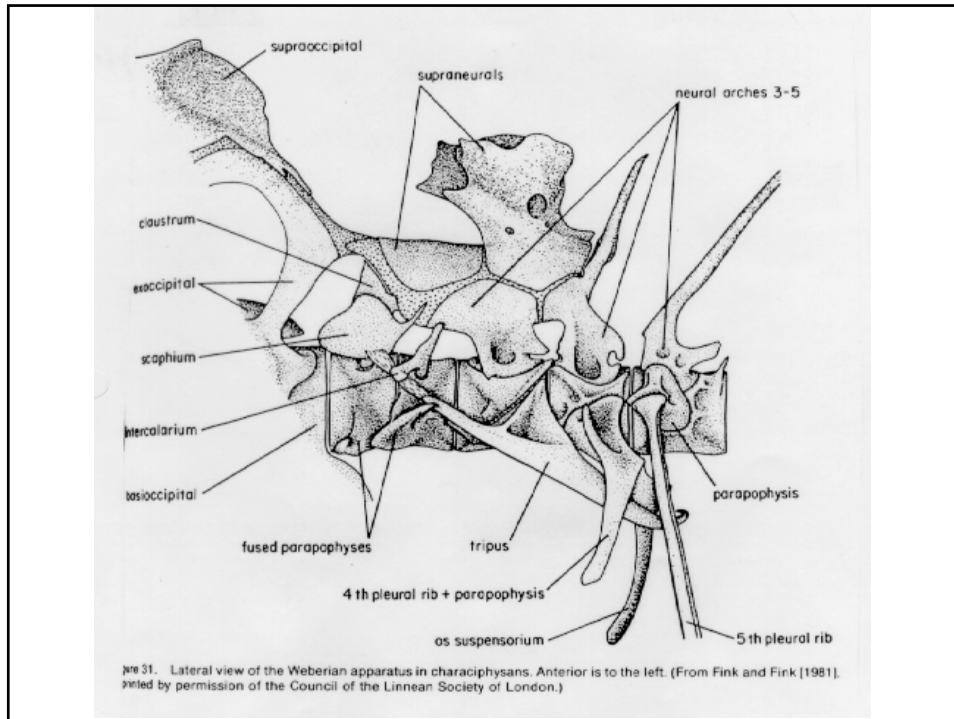
Dominant freshwater in all continents except New Zealand, Australia and Antarctica (which has none).



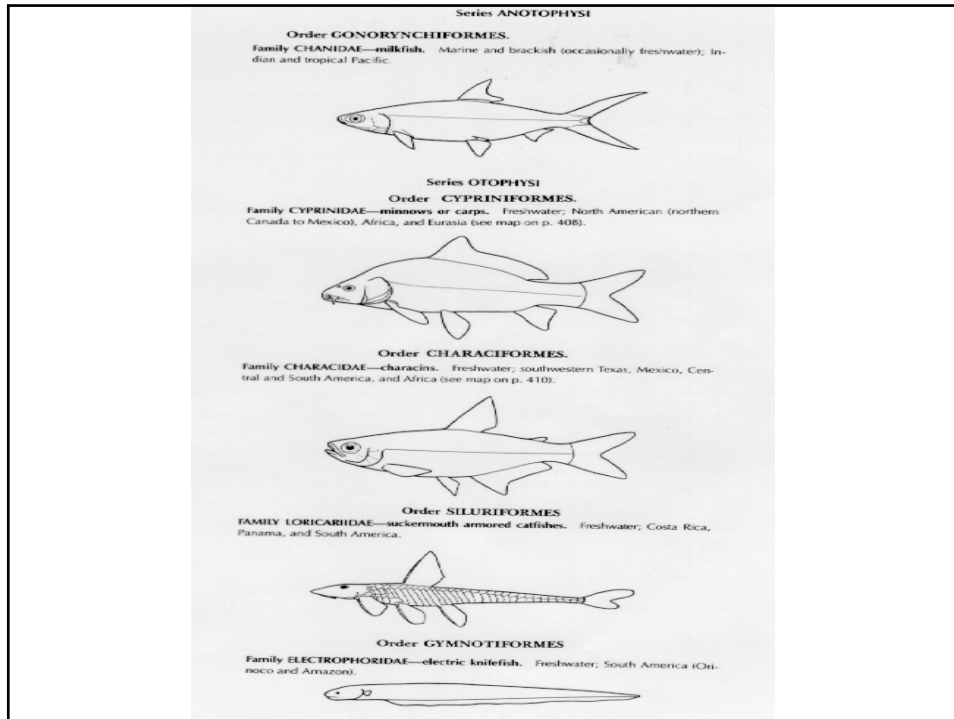
Ostariophysi

- All share a so-called weberian apparatus - a complex otophysic connection involving considerable specialization of the swimbladder, inner ear, ligaments and anterior vertebrae.
- This is important locus of change within clade. Functionally - little doubt that weberian apparatus improves hearing capability
- Chain of bony ossicles (derived from vertebral process) link the swimbladder with inner ear. Change in swimbladder volume as sound waves pass through fish - rock the tripod
- Movement transferred through intercalium and schaphium to claustrum which abuts onto perilymphatic sinus impar - this linked to endolymphatic transverse duct joining sacculi of either side - wide range of frequencies and capable of directional hearing.

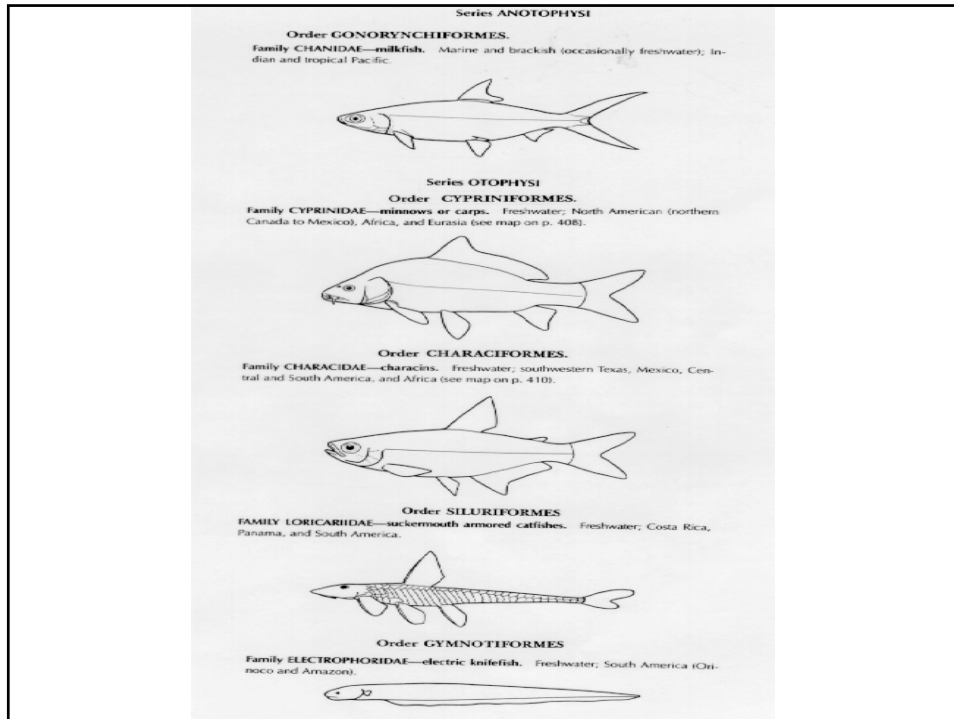




- What are gonorynchiforms? - Four families
- 1) Chanidae 'milkfish' marine/brackish India/Tropical pacific regions. *Chanos chanos* (primitive taxon)
- 2) Gonorynchidae (*Gonorynchus gonorynchus* –marine Indo-pacific) - related to
- 3) Kneriidae and 4) Phractolaemidae (freshwater tropical Africa) - both highly protractile upper jaw - very peculiar mechanism (independent of cypriniform). Kneriidae- 4 genera 24sp Phractolemidae - *Phractolaemus ansorgei*
- Unlikely sister group to Otophysan freshwater radiation - interesting feature uniting with the otophysans
- Presence of "fright reaction" and production of "alarm substance" (shreckstoff), pheromone produced by specially modified epidermal club cells.
- What is the "fright reaction" - changes behavior of fish dramatically:
 1. Swim excitedly with heads against bottom, body at 60°.
 2. Become motionless and show no movement for several minutes
 3. Flee to the surface frequently jumping out of the water
 4. Flee to the depths and form a school.
- Directed at own species - but cases detected by all ostariophysans (gonorynchiform and otophysan alarm substance acts reciprocally - same structure).
- Some ostariophysans lack the fright reaction (some still produce) reaction is absent (e.g. blind cave fish, piranhas, armored catfish, electric knife fish) seem to be either cave dwelling, predaceous, nocturnal, electric or armored. Assume secondary loss
- Fishes showing the reaction tend to be - social, lack defensive structures and are generally non-predaceous.
- Alarm substance produced by specialized club cells - no connect surface - injuries skin release contents
- Capture of minnow by pike creates sufficient damage to release alarm substance - alerting other minnows
- Evolution of fright reaction - considered protection against predation - not protect individual but alert school.
- Found only in otophysans and gonorynchiforms.



- Leaves Otophysi -
- Look at them; add some species numbers
- Chanos 1. Gonorynchforms - 26
- Cypriniformes 2422 (6 families 256 genera)
- Characiformes 1335 (10 families 253 genera)
- Gymnotoids 55 (6 families 23 genera)
- Siloroids 2211 (30 plus families 400 genera)
- Cypriniformes - huge group includes minnows and carp-like
- Cyprinidae - freshwater North America, Africa and Eurasia; Hillstream loaches of India, China, Malaya and Borneo (Psilorhynchidae and Homalopteridae). Real radiation in old world
- True cobitid loaches - of Eurasia, and North Africa - Finally the suckers - catostomids - North America, China and Northeast Siberia.
- Concentrate on Cyprinidae - minnows and carps.
- Fantastic radiation of > 2070 species - largest family (Cichlidae?)
- Series of parallels between these fish and acanthomorph radiation - while these dominate in freshwater and acanthomorphs in marine
- Two species can live in salt-water - but salt lethal to most.
- In terms of sensory biology - vision and taste are well-developed (barbels present in many - taste buds increased area) – mainly diurnal many are brightly colored and many are schooling.
- Body is usually fully scaled - dorsal and anal fin may have pungent spines (acanth.)



Buccal jaws lack teeth, but upper jaw is highly protrusive. Cyprinid jaw protrusion mechanism differs radically from that of Acanthomorphs but functions to improve high-speed inertial suction.

All systems have analogous features:

- 1. Median rostral cartilage
- 2. Overlain by premaxillary process
- 3. Head of maxilla bears a condyle that articulates via a meniscus with ethmoid
- 4. A superficial layer of the adductor mass insert on maxilla

Also an important innovation of neoteleosts involving elaboration of pharyngeal jaw apparatus - is mirrored in the cyprinids (again in parallel)

Truly mobile crushing LPJ - grind and crush essentially; Herbivorous diet - Acanthomorphs - identify series of derived feature that seemed to define the assemblage - also recurrent parallel theme in cypriniform lineages.

Given evolutionary distance between groups, assumed were convergent developments - however, fact that seemingly similar morphologies derived twice was very interesting and somewhat disconcerting -

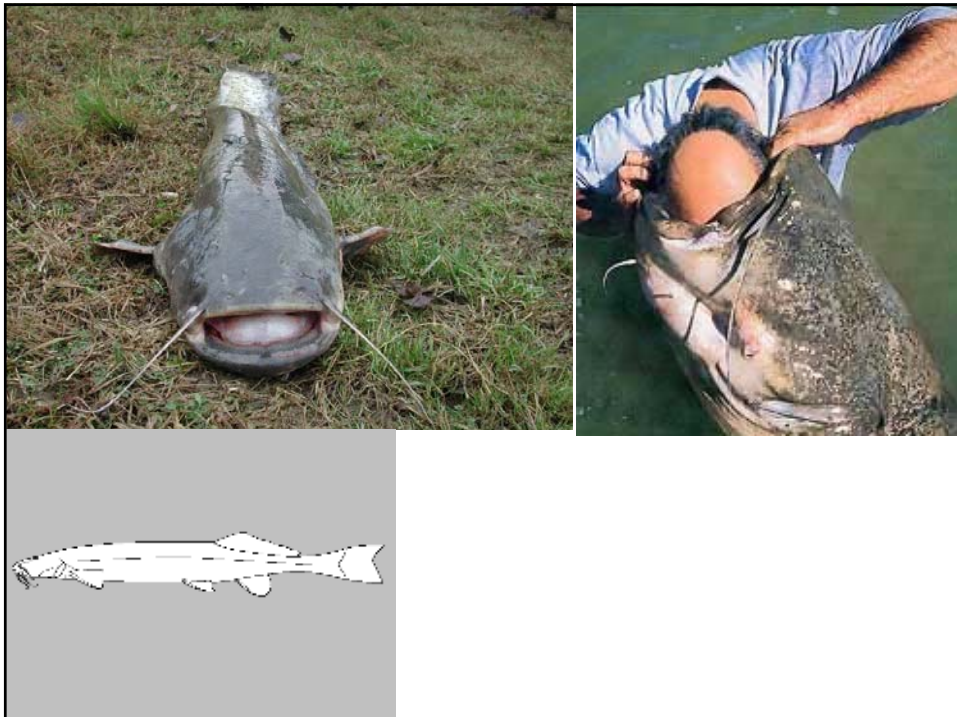
- Suggestive of possibility of independent characters may be functionally correlated (with jaw protrusion).

Interesting way - systematic analysis can stimulate functional studies and vice versa.

Characiformes – Ecologically diverse,
adipose fin, replacement dentition, and
ctenoid scales – Africa (Tiger fish) – tetras,
pacus, silver dollars, piranhas.



Siluriformes – teeth on roof of mouth, reduction in skull bones, adipose fin, locking spines; Naked = lack true scales but some have overlapping bony plates; some huge 3 m – 330 kg = *Silurus glanis*. NA = flathead and blues = 1.5 m; Candiru = trichomycterids swim into urethra??=rheophilic, Air breathing and terrestrial locomotion



Gymnotids – Most advanced, produce and receive weak electric impulses – South American Knifefish (not osteoglossiform)



Gymnotids – Most weak except Electric eel (Electrophorus) not true eel but close relative = 500 volts to stun and weak for electrolocation



Protacanthopterygii

- Characters that unite group:
- Adipose fin
- No spiny fin rays
- Pelvic axillary process-flap base of pelvic fin
- Maxilla included in gape
- Vertical barring in young = parr marks
- Myodome present (eye muscles insert)
- Species flocks

Superorder – Protacanthopterygii

- 3 forms of diadromy:
- Anadromy – spawn fresh, juvs to salt, return to fresh to spawn (Salmon, Lampreys, Sturgeon, Herring, Arridae, smelts, cods, Sculpins, gobies, soles)
- Catadromy – Adults spawn at sea, juvs move to fresh for several years and return to sea to spawn. Anguillidae, Galaxiidae, Mulletts, Centropomidae
- Amphidromy – Spawn fresh or salt; larvae migrate to other habitat for initial feeding and growth then return for more growth before spawning. (Herring, Galaxids, southern grayling, Sculpins, pipefish etc.

Superorder – Protacanthopterygii

- Esociformes – Pikes and mudminnows; maxilla bone in gape but toothless



Superorder – Protacanthopterygii

- Osmeriformes – Smelts, icefish, argentines etc.; Marine, Freshwater and diadromous.
Galaxioidea – (Salamander fish lack eye muscles – move neck) .



Superorder – Protacanthopterygii

- Salmoniformes – Very important commercially, Three major groups: Coregonid whitefishes, thymallid graylings and salmonid salmons. = Unite into one major group the Salmonidae??



Lake Whitefish
Coregonus clupeaformis

Superorder – Protacanthopterygii

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- Coregonid whitefishes = Whitefishes and ciscos (32 species that lack teeth on maxillary) Graylings = 5 species w/ elongate flowing dorsal fin



Grayling
Thymallus arcticus

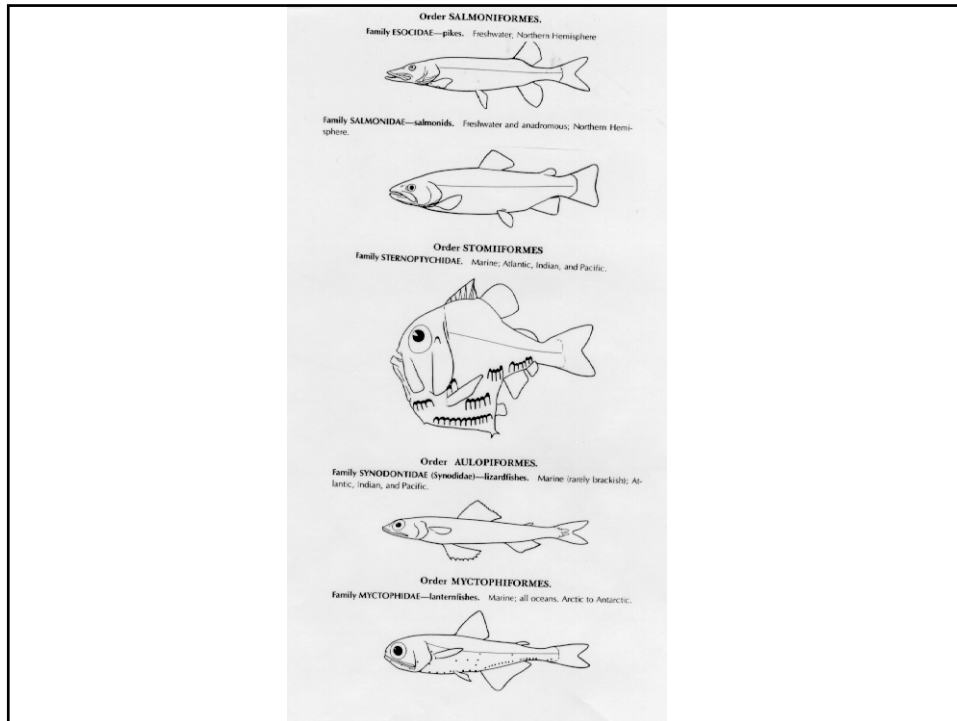
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Salmoniformes

- In seven genera; Number of species in doubt – Genetically distinct stocks – unique evolutionary units; Economically important and major issue.



- Next = Neoteleosts
- NEOTELEOSTS = 3 groups + ACANTHOMORPHA
- ACANTHOPTERYGII = Mugilomorpha + Atherinomorpha + Percomorpha