Teleost Radiation

Teleostean radiation - BIG ~ 20,000 species. Others put higher 30,000 (Stark 1987 Comparative Anatomy of Vertebrates)

About 1/2 living vertebrates = teleosts

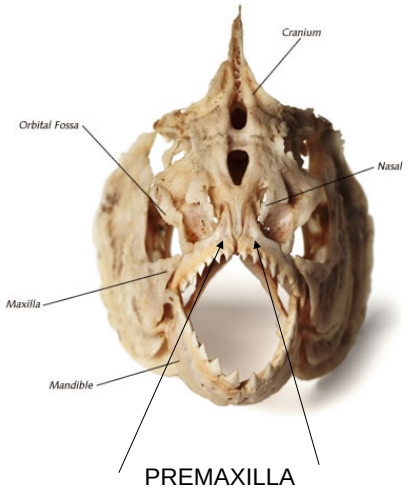
Tetrapods dominant land vertebrates, teleosts dominate water.

First = Triassic 240 my; Originally thought non-monophyletic = many independent lineages derived from "pholidophorid" ancestry. More-or-less established teleostean radiation is true monophyletic group

Teleost Monophyly

- Lauder and Liem support this notion:
- 1. Mobile premaxilla - not mobile like maxilla halecostomes = hinged premaxilla modification enhancing suction generation. Provides basic structural development of truly mobile premaxilla, enabling jaw protrusion.

Jaw protrusion evolved independently 3 times in teleostean radiation 1) Ostariophysi – Cypriniformes; 2) Atherinomorpha and 2) Percomorpha – especially certain derived percomorphs - cichlids and labroid allies



PREMAXILLA

Teleost Monophyly

- Lauder & Liem support notion:
- 2. Unpaired basibranchial tooth plates (trend - consolidation dermal tooth patches in pharynx).
- Primitive = whole bucco-pharynx w/ irregular tooth patches – consolidate into functional units - modified w/in teleostei esp. functional pharyngeal jaws.

Teleost Monophyly

- Lauder and Liem support this notion:
- 3. Internal carotid foramen enclosed in parasphenoid (are all characters functional, maybe don't have one - why should they?)

Teleost Tails

- Most interesting structure in teleosts is caudal fin.
- Teleosts possess caudal skeleton differs from other neopterygian fishes - Possible major functional significance in Actinopterygian locomotor patterns.

- Halecomorphs-ginglymodes = caudal fin rays articulate with posterior edge of haemal spines and hypurals (modified haemal spines). Fin is heterocercal (inside and out).

Ginglymod - Gars

Halecomorph - Amia

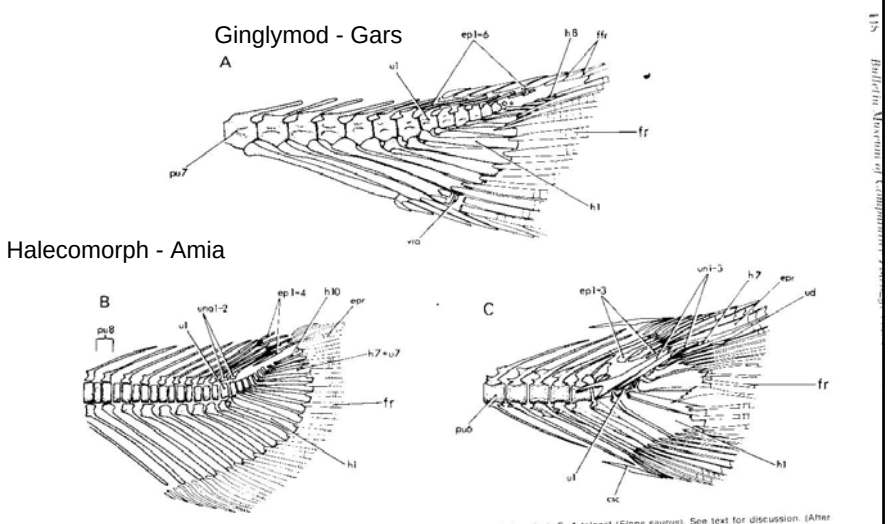


Figure 15. Caudal skeleton. A, A ginglymod (*Lepisosteus osseus*). B, A halecomorph (*Amia calva*). C, A teleost (*Elops saurus*). See text for discussion. (After Patterson [1973], reprinted by permission of the Council of the Linnean Society of London.)

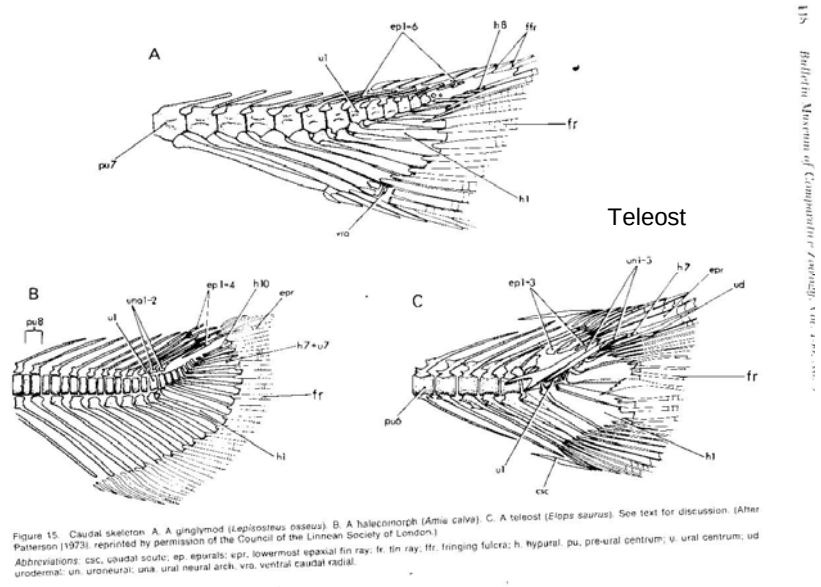
Abbreviations: csc, caudal scute; ep, epurals; epr, lowermost epaxial fin ray; fr, fin ray; ffr, fringing fulcra; h, hypural; pu, pre-ural centrum; u, ural centrum; ud urodermal; un, uroneural; ura, ural neural arch; vra, ventral caudal radial.

Tails

- “Chondrostean hinge” at base of upper lobe - weakness btw body and tail lobe. Asymmetrical tail = asymmetrical thrust with respect to body axis.

Teleost Tail

- Teleosts
- (1) Ural neural arches elongated into uroneurals. Ural neural arches modified into uroneurals - stiffen upper lobe and serve also as insertion site for dorsal fin rays.
- (2) Preural and ural centra is important (esp. w/in teleostei where numbers and fusions are significant). Pre-urals carry normal haemal arches and spines - ural centra carry hypurals. Boundary marked by caudal artery and vein.
- (3) The hypurals expanded - into a broad plate
- Internally asymmetrical but externally symmetrical tail fin.



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- Early teleosts - uroneurals small; Advanced teleosts uroneurals extend across centra, eliminate line of flexion in upper lobe.
- Functionally assumed symmetrical tail means symmetrical thrust.
- Lauder - Found continuous locomotion hypurals appear to distort and twist resulting in anterioventrally inclined thrust (asymmetrical). Fast start accelerations strain patterns consistent with symmetrical anteriorly directed thrust.

CLC = continuous locomotion

FS = fast start

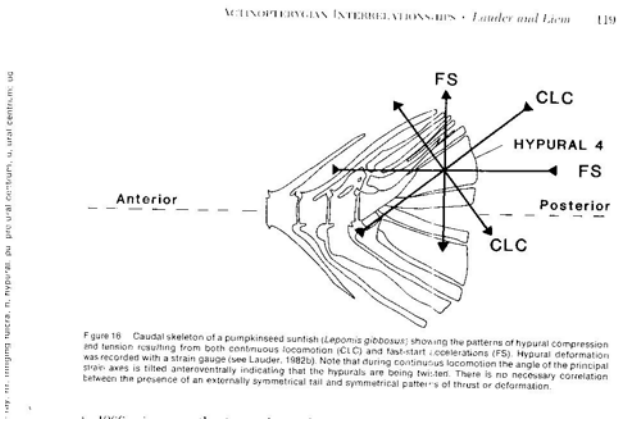


Figure 16 Caudal skeleton of a pumpkinseed sunfish (*Lepomis gibbosus*) showing the patterns of hypural compression and tension resulting from both continuous locomotion (CLC) and fast-start accelerations (FS). Hypural deformation was recorded with a strain gauge (see Lauder, 1982b). Note that during continuous locomotion the angle of the principal strain axes is tilted anteroventrally indicating that the hypurals are being twisted. There is no necessary correlation between the presence of an externally symmetrical tail and symmetrical patterns of thrust or deformation.

Other Teleost Traits

- Teleosts have Mauthner system - specialized nerve cells.
- Located in medulla - two giant nerve cells - each accompanied by two enlarged dendrites that synapse with acoustic (viii) nerve.
- Circuitry underlying the tail-flip escape reflex includes a pair of giant medullary neurons called Mauthner cells
- Possibly - rapid escape actions functional advantage of teleostean caudal structure - important biological role?

TAXONOMY AT LAST

- Four major groups.
- 1) Osteoglossomorpha
- 2) Elopomorpha
- 3) Clupeomorpha
- 4) Euteleostei - this last group is enormous and complex

Osteoglossomprph

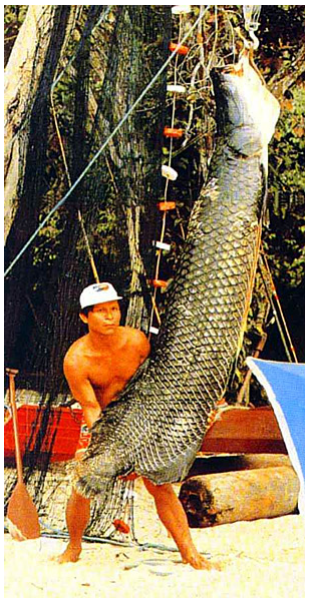
- Osteoglossomorphs (bony tongues) - most phylogenetically primitive living teleosts. First fossils known from Upper Jurassic (163-144 my).
- Group derives name from presence of tongue - Parasphenoid bite that is very well developed in some members. Have large tooth plates on the tongue (basihyal) and basibranchials that oppose the parasphenoid toothplates. Prey capture is initially by inertial suction - once into expanding cone, tongue-bite results in prey processes

Osteoglossomprph

- Number characteristics shared (by living osteogossomorphs) Two are:
- 1)Peculiar arrangement of gut and 2) Presence of a peculiar ventral process on hypobranchials 2 and 3.

- Lauder and Liem's hypothesis of osteoglossomorph interrelationships.
- Divided into two main groups. A) Osteoglossoidei and B) Notopteroidei

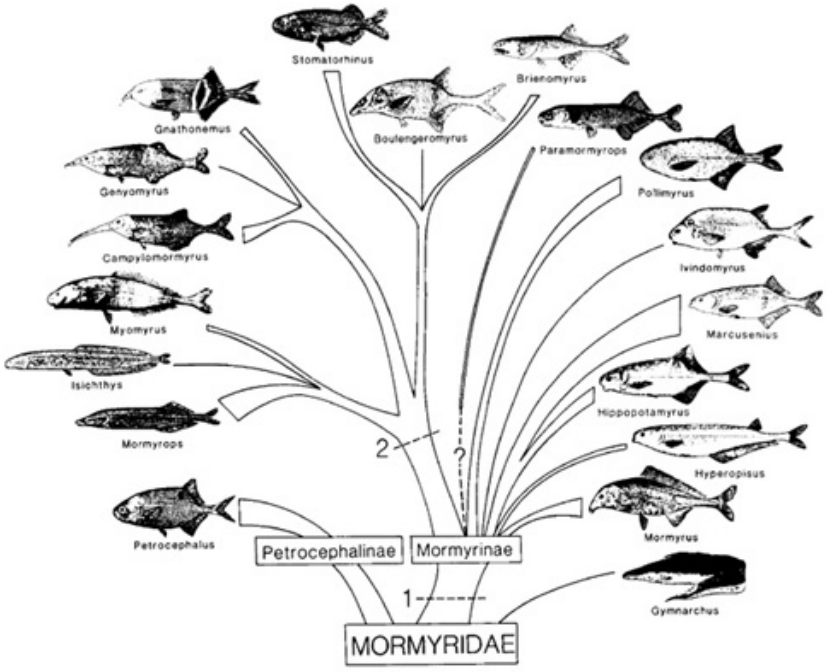
- A) Osteoglossoidei = Osteoglossum 2 sp. S.A. & Scleropages 2 sp. India & SE Asia = united in osteoglossidae
- Pantodon 1sp. West Africa - Pantodontidae, Arapaimidae = Heterotis 1sp. West Africa & Arapaima 1sp South America
- All evolved mouth brooding behavior and interestingly it is paternal fish that broods.



Osteoglossomprph- Neotopteroidei

- Neotopteroidei = Tremendous mormyrid radiation. Well-established group - peculiar type of otophysic connection (btw ear and swimbladder), also strangely modified ventral branchial muscles.
- Mormyridae - widespread African family - nearly 200 species described and Gymnarcus niloticus, and together called Mormyriformes
- African species are electroreceptive while Indian species are not.

- Hiodontidae -2 species- Hiodon tergisus (mooneye) and Hiodon alosoides (goldeye). Widespread throughout middle North America.



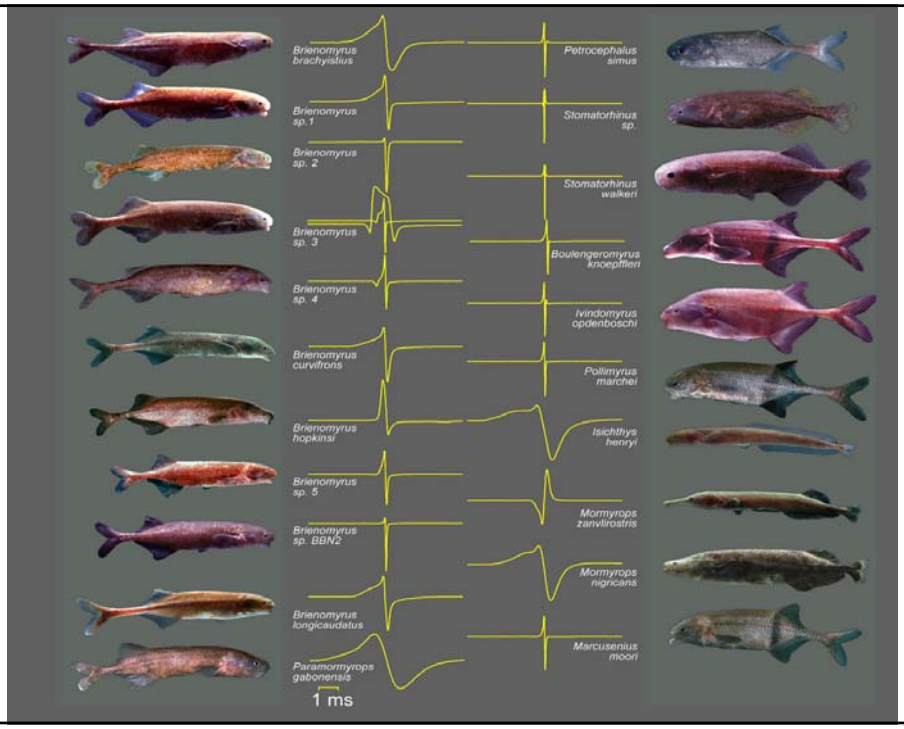
Mormyriformes dominate

- Why group within lineage is so "successful" or speciose.
- Mormyrids widely distributed throughout sub-Saharan Africa. Riverine group.
- Show variation in feeding regime - mostly bottom insectivores, two mormyrus and gynarchus are piscivores. And *Pollimyrus isidori* is a midwater plankton feeder (seen in aquarium it feeds on bottom)

Mormyriformes dominate

- Most nocturnal. Small eyes, lack bright coloration.
- Complex social communication via unique electrical modality. Electric communication used in aggression, courtship and appeasement, and in identifying sex, species and individual.
- Electroreception: believed that electroreception is ancestral vertebrate sense, widely present in lower aquatic vertebrates - appears to have been lost in teleostean ancestry
- Within the teleostei has been re-evolved at least twice -
- Osteoglossomorphs:
- Ostariophysans (catfishes and gymnotid eels):

- Lateral line - complex sensory system - cutaneous sensory organs over head and trunk detect pressure waves in water - giving fish so-called distant touch ability - in some teleosts - modified into electroreceptors
- Mormyriforms - weakly electric fish. Electric organ (in tail) = modified muscle tissue. Organ discharges continuously. Weak current (can't feel or do any damage).
- Contrasts with strong electric fish - Electric eel (Gymnotidae) generates shocks = 500 volts and 1 ampere. Prey capture device.
- Before electroreception in fishes discovered this difference caused a problem. Why aren't weak electric fishes evolving into strong electric fishes? Answer doing a different thing - not prey capture. Electroreception (navigation) and communication; weak because energy cost of a continuous strong field would be prohibitively high



TAXONOMY AT LAST

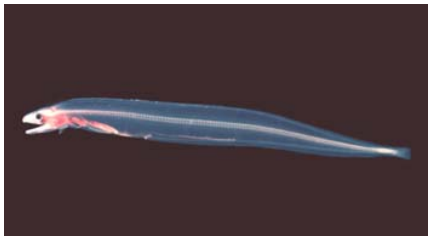
- Four major groups.
- 1) Osteoglossomorpha
- 2) **Elopomorpha**
- 3) Clupeomorpha
- 4) Euteleostei - this last group is enormous and complex

Elopomorpha

- 2 elopocephalan lineages: Elopomorpha & Clupeomorpha - long time included together - clearly two distinct teleostean lineages
- Elopomorpha - comprising about 650 species - most Elopomorphs primarily marine fishes
- Earliest fossils from Cretaceous (110 my).

Why elopomorphs united?

- 1. Leptocephalus larva - discovered 1777, distinct group of fishes? Recognized larvae century later. Elongate, compressed nearly transparent body. Series of myomeres covers most of lateral area of the body. Head small compared with body and rudiments of dorsal, anal and pectoral fins are present. Basic structure of leptocephalus is same in all Elopomorphs



Why elopomorphs united?

- 2. Fusion of angular and retroarticular bones of ower jaw.
- Virtually all teleosts angular bone fused with articulars.
- Elopomorphs have fusion between dermal angular and endochondral retroarticular - forming an angulo-retroarticular element.

- 3. Presence of rostral and prenasal ossicles. Ossicles associated with acousticolateralis system that extends over teleosts head. Uniquely elopomorphs have variable number of additional dermal (canal bearing) ossicles in rostral region forming bone.

Elopomorpha = 5 major groups

- Elopids (tenpounders) - Elopidae - tenpounders. Mainly marine in tropical and subtropical oceans.
- Megalopids (tarpons) - Megalopidae - tarpons. Tropical and subtropical marine although tarpon enters freshwater.
- Albuloids (albulids and pterothrissids): Albuloidei – albuloids (bonefishes) and halasauroids (Deep sea spiny eels)
- Anguilloids (eels) - By far largest group of elopomorphs are anquilloids; 19 families 147 genera and over 600 species
- Saccopharyngoids - Most bizarre - 3 genera, 11 species.

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Clupeomorpha

- Clupeomorpha - clearly defined aggregates of living teleosts - five families with about 300 species) – but unsurpassed in terms of biomass and importance for fisheries.
- Largest taxon of non-domesticated vertebrates harvested by man. Total world fish catch (1991) at ~60-70 million tons

- Clupeoid populations - striking increases and precipitous declines. Peruvian anchoveta - *Engraulis ringens* - increased from negligible fishery (1950's) to 8-12 million tons (1960's) crash to 2 million tons (1973). Decline associated with recruitment failure caused by El Nino - combined with management policy that led to over fishing.

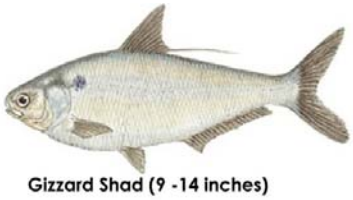
Features of Clupeids?

- Neurocranium architecture- two prominent foramena - temporal (bordered by frontals & parietals) and auditory foramen (bordered by prootic, exoccipital & basioccipital)
- Unique caudal skeleton - urostyle composed of uroneural one fused with last preural centrum. Hypural 1 is autogenous.
- Unique otophysic connection between swim bladder and inner ear. Recessus lateralis chamber in pterotic bone. Also unique is Otophysic connection - Swimbladders anterior extension lodge within two ossified bullae

Who are clupeids?

- Denticipitoidei - known only from extant monotypic genus Denticeps. Strange little fish covered in denticles.
- Engraulidae - Anchovies, 16 genera 140 species worldwide - Characteristic snout overhanging mouth:
- Chirocentridae- wolf herrings - one of few predatory clupeoids.
- Dussumieriidae - round herrings 7 genera and about 10 species
- Clupeidae - herrings, shads and menhadens 50 genera and 190 species.

Denticeps and Shad



Gizzard Shad (9 -14 inches)

Threadfin Shad (1 - 5 inches)

Threadfin shad are usually easily distinguished from the gizzard shad by the fact that the upper jaw does not project beyond the lower jaw

Anchovies and Herring