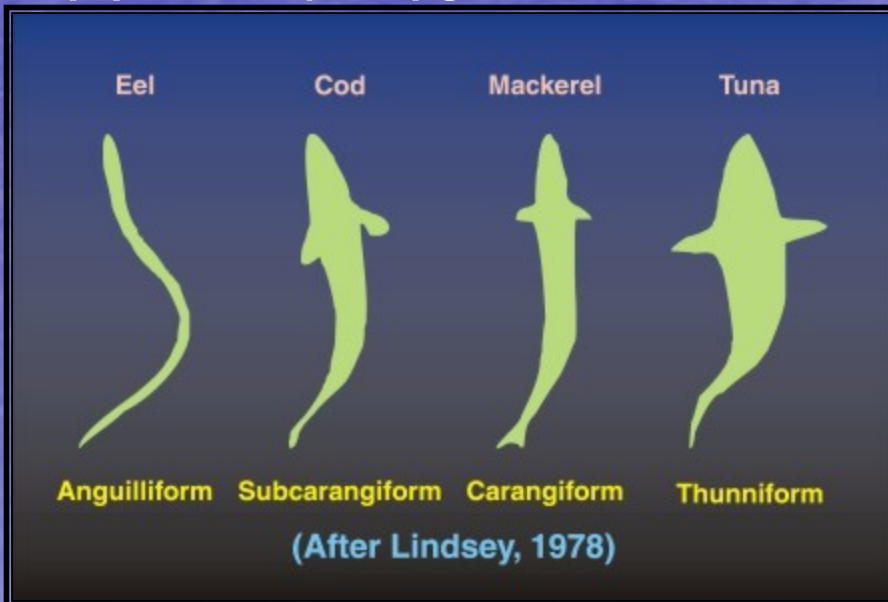
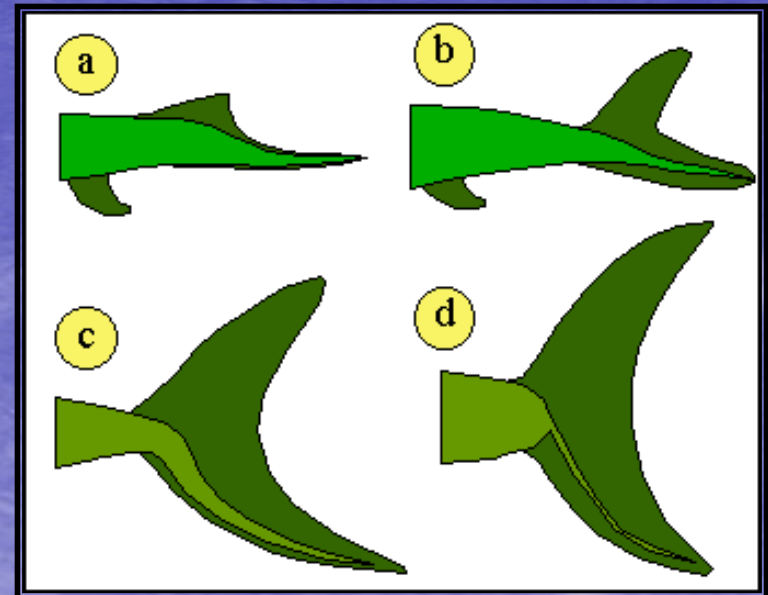


Ichthyosaurs

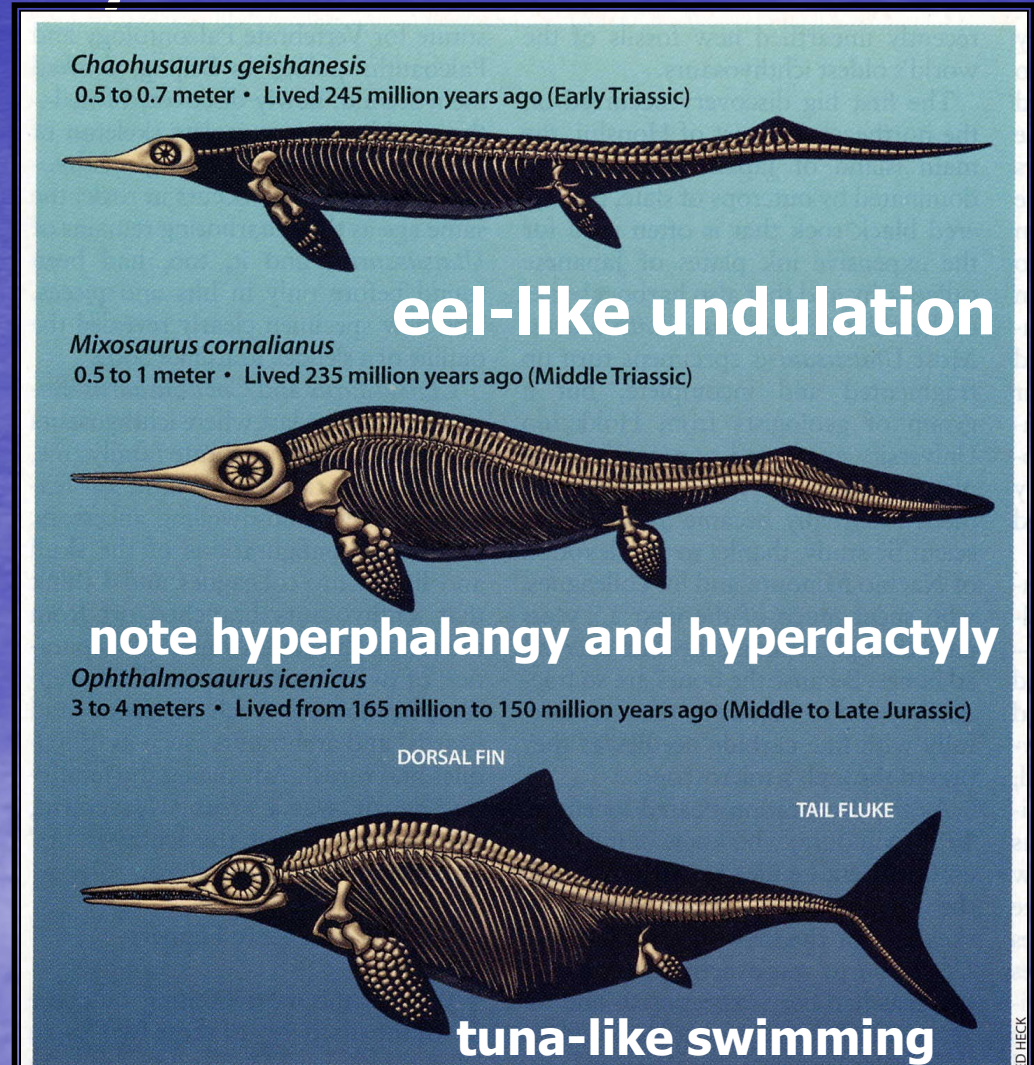
Remember:

- Most basal (Triassic) ichthyosaurs used anguilliform motion or a heterocercal tail
- Not as fast/maneuverable
- (a) *Mixosaurus*
- (b) Juvenile *Stenopterygius*
- (c) Adult *Stenopterygius*
- (d) *Macropterygius*



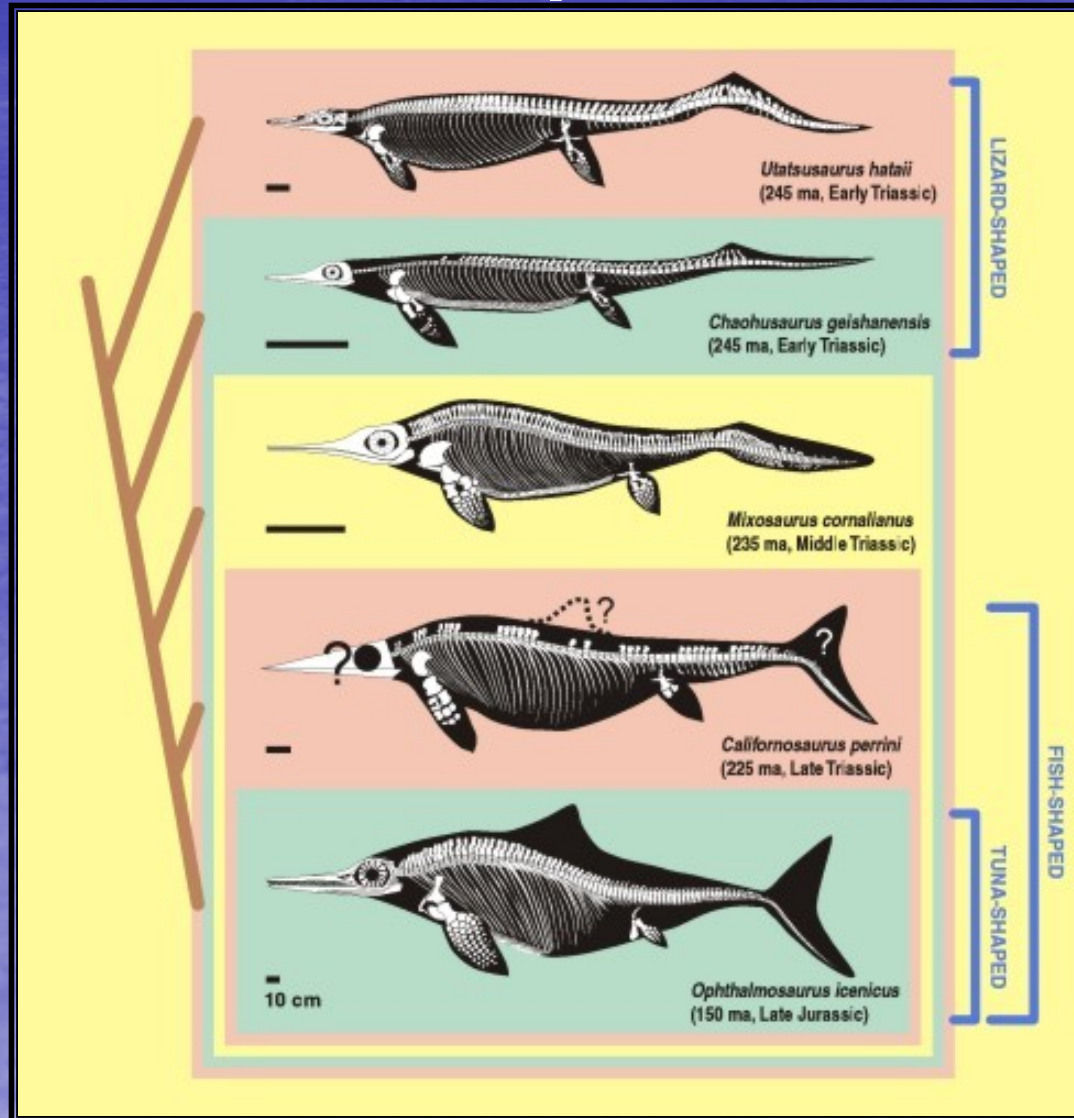
Trends in Ichthyosaur Evolution

- More streamlined-
"thunniform"
- Caudal fin propulsion
- Stiffened thorax
- Homocercal caudal fins



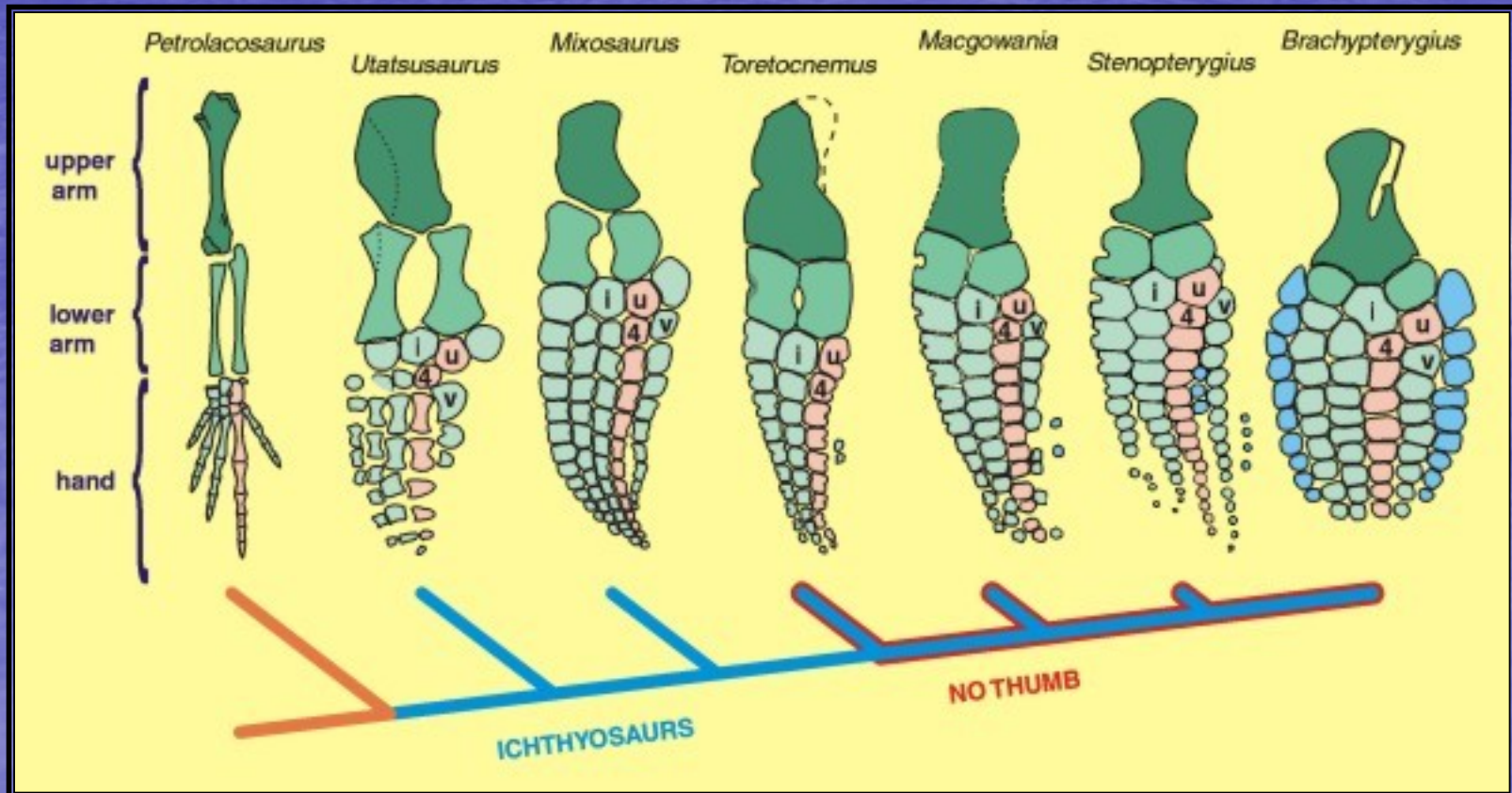
ANCIENT SKELETONS have helped scientists trace how the slender, lizardlike bodies of the first ichthyosaurs (*top*) thickened into a fish shape with a dorsal fin and a tail fluke.

Trends in Ichthyosaur Evolution



Trends in Ichthyosaur Evolution

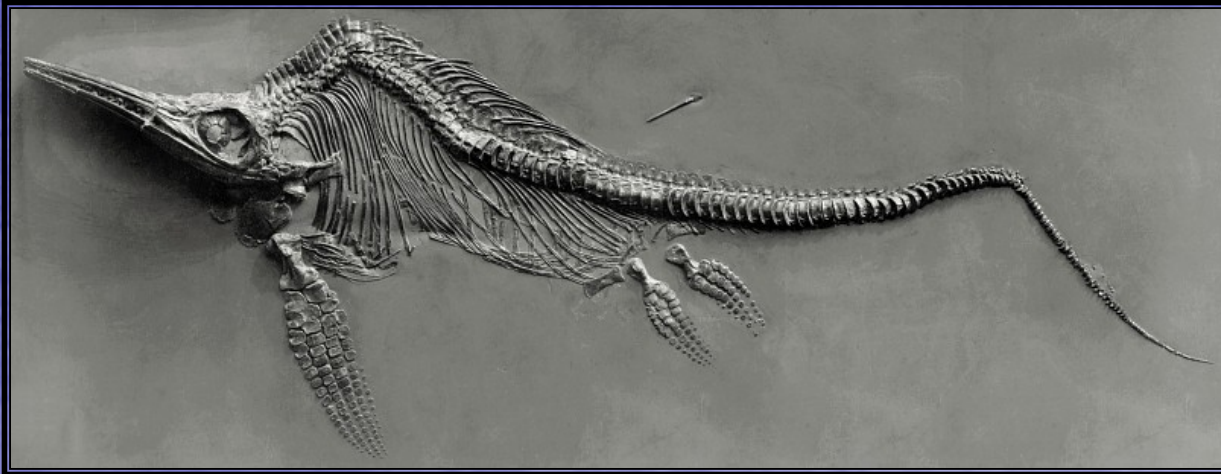
- Forefins: used for steering/maneuvering, not paddling (shoulder girdles not robust)
- Thumb disappeared, then other digits were added



Trends in Ichthyosaur Evolution



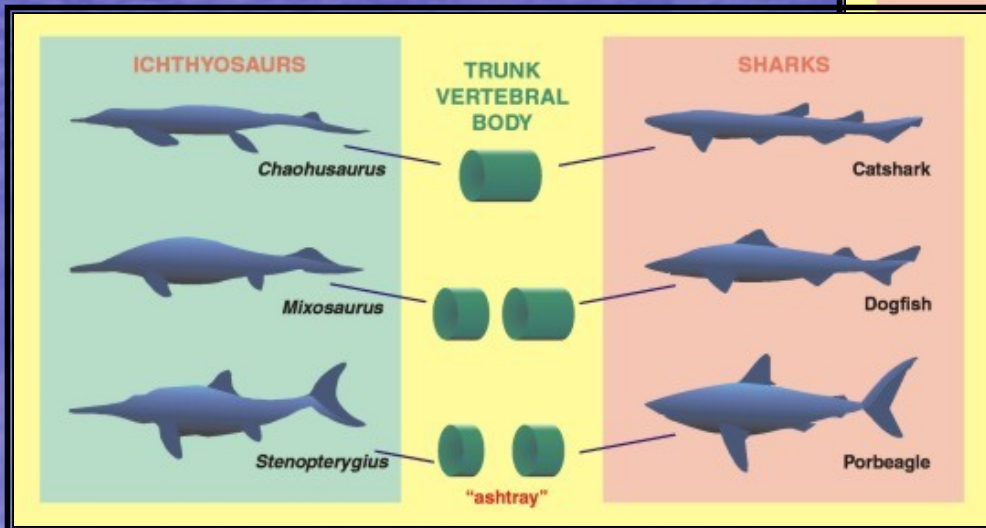
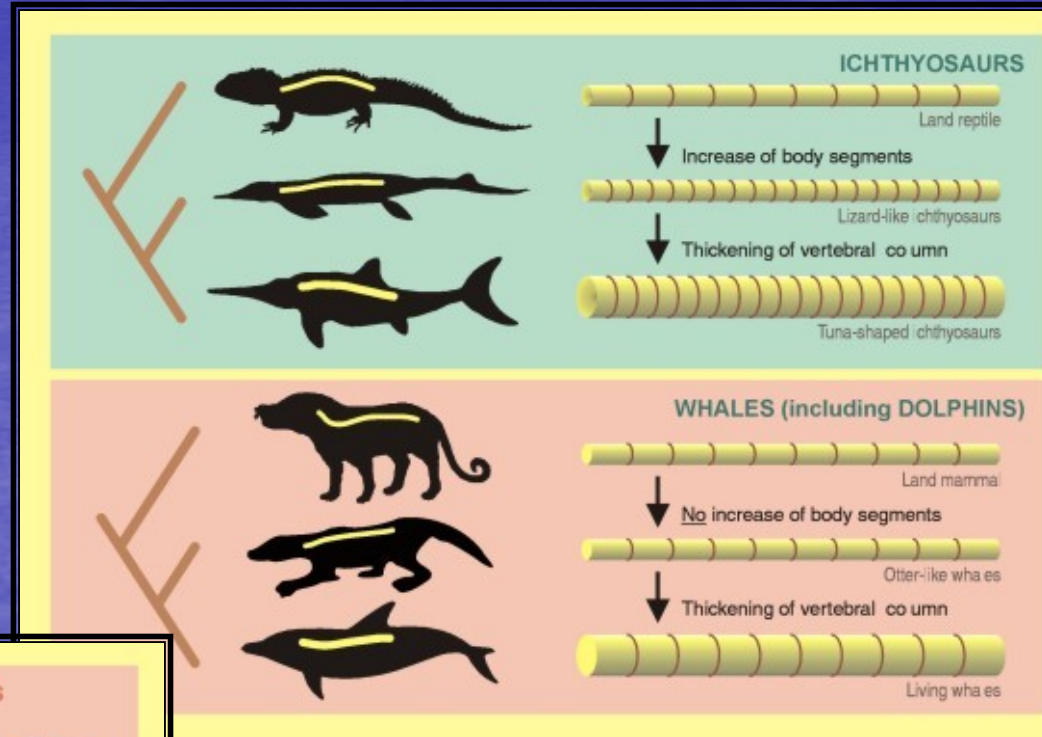
- *Chaohusaurus* (“lizard with flippers”) has vertebral spools shaped as in terrestrial animals (like film cans)



- More typical ichthyosaurs have hockey-puck vertebrae

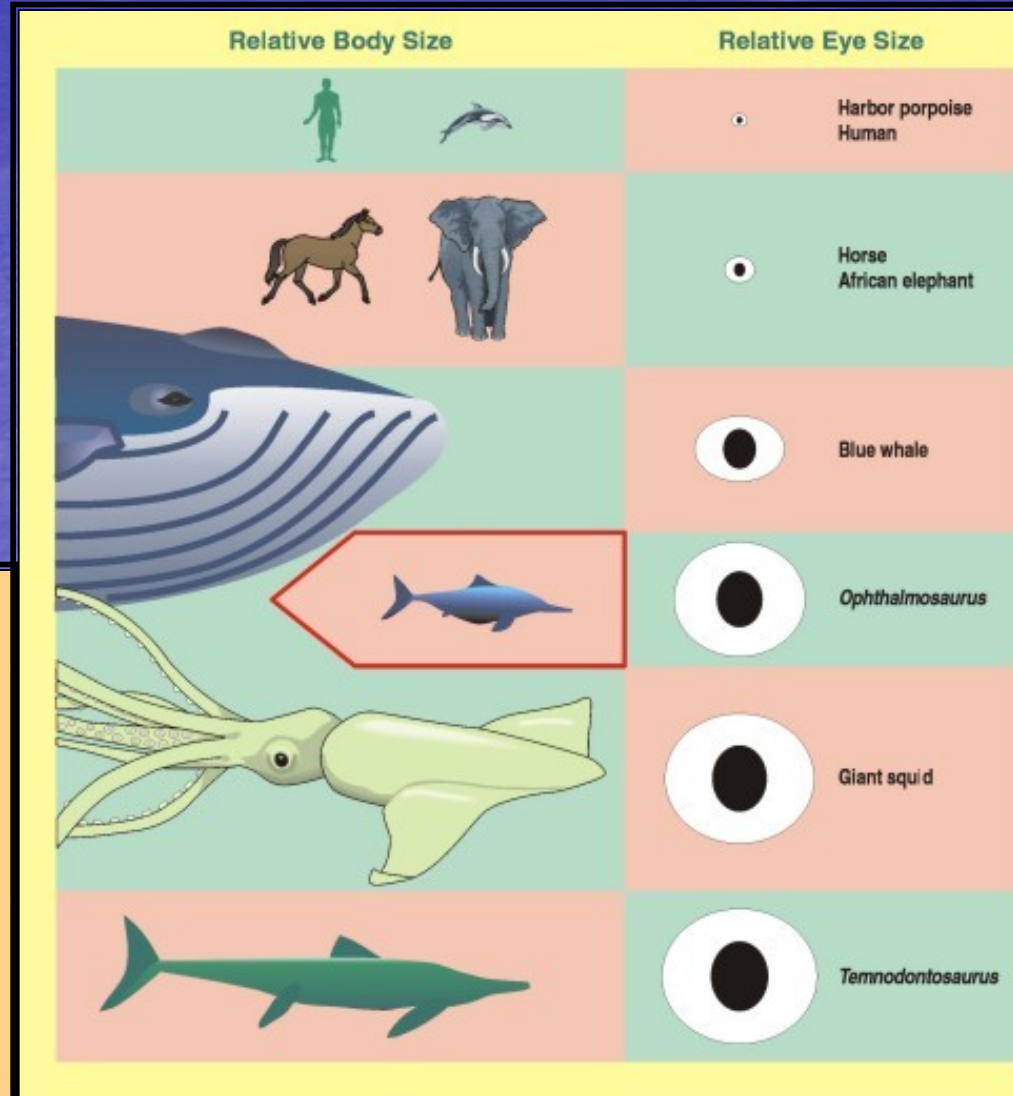
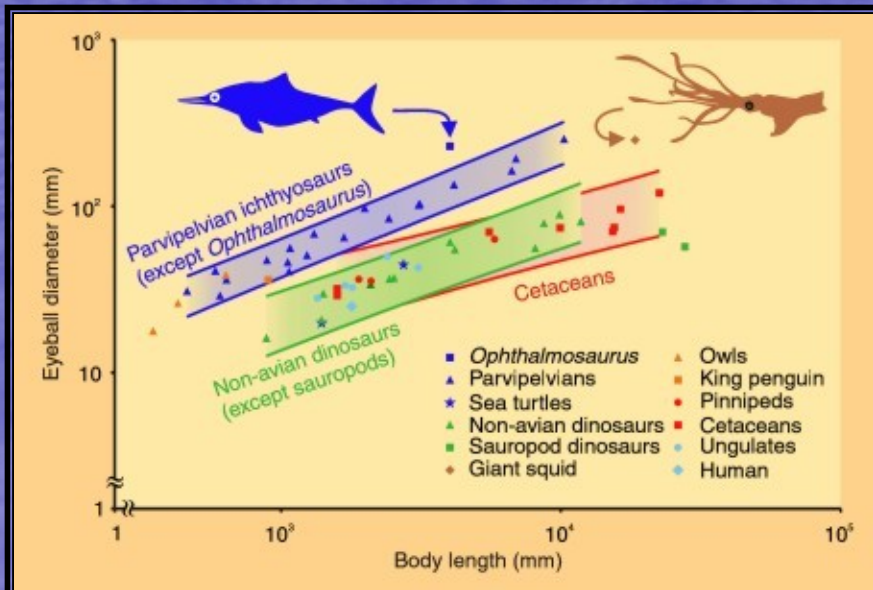
Ichthyosaur Vertebrae

- Increase in number of spinal vertebrae + stiffening of spinal column = "hockey-puck vertebrae"



Ichthyosaur Eyes

- Largest eyes of any animal: 264 mm (*Temnodontosaurus*)



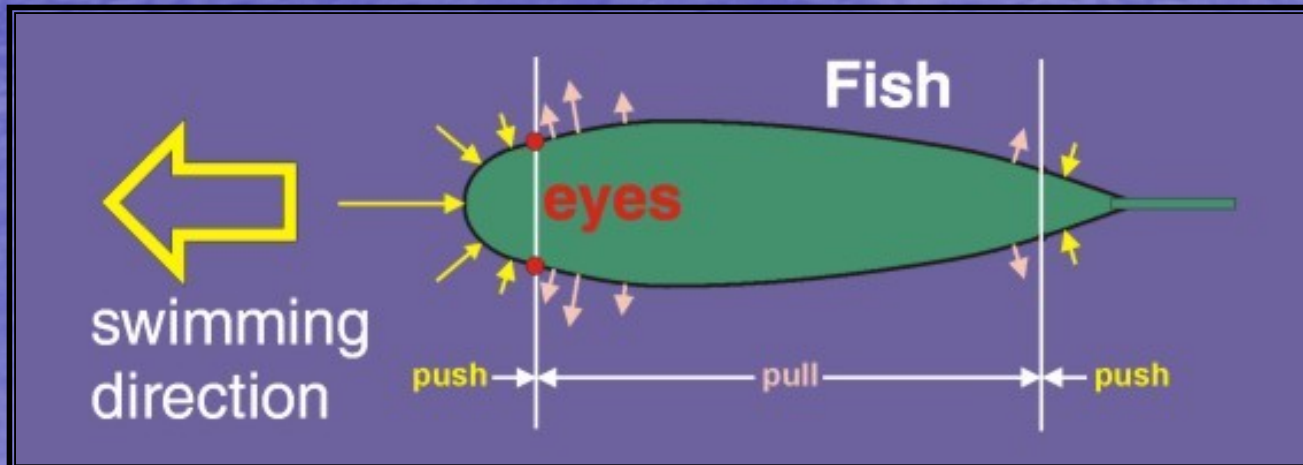
Ichthyosaur Eyes

- f-numbers: relative brightness of optical system
- The smaller it is, the more light it take in
- Comparative ophthalmology suggests ichthyosaurs had low f-numbers

Animal Eyes	
Animal	Minimum f-number
Human	about f/2.1
Owl	about f/1.1
Cat	about f/0.9
<i>Ophthalmosaurus</i>	f/0.8 to f/1.1
<i>Ichthyosaurus</i>	f/1.1 to f/1.3

Ichthyosaur Eyes

- Sclerotic rings maintain eye shape during locomotion



Viviparity

- Giving birth to live young that have passed embryonic stage inside the mother
- Ichthyosaur specimens have been found with young inside or partially expelled from gas buildup



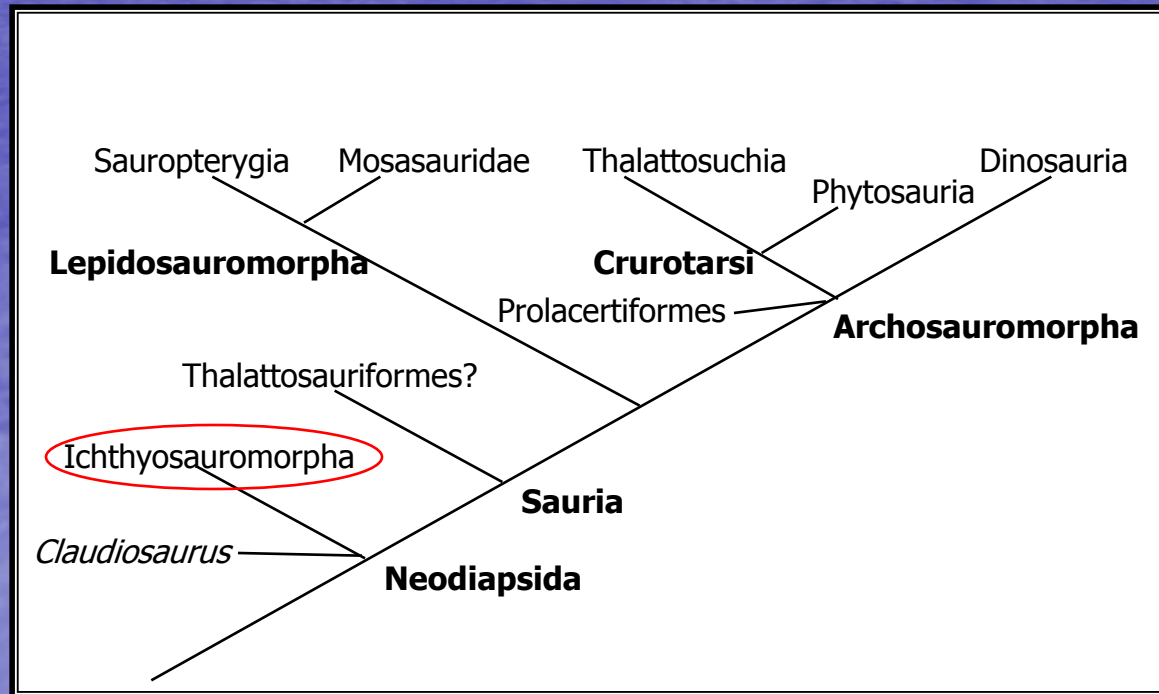
Problems with Ichthyosaur Taxonomy

- Earliest forms in fossil record already relatively derived (completely aquatic)
- No transitional species (same as turtles)
- May be instance of extreme punctuated equilibrium



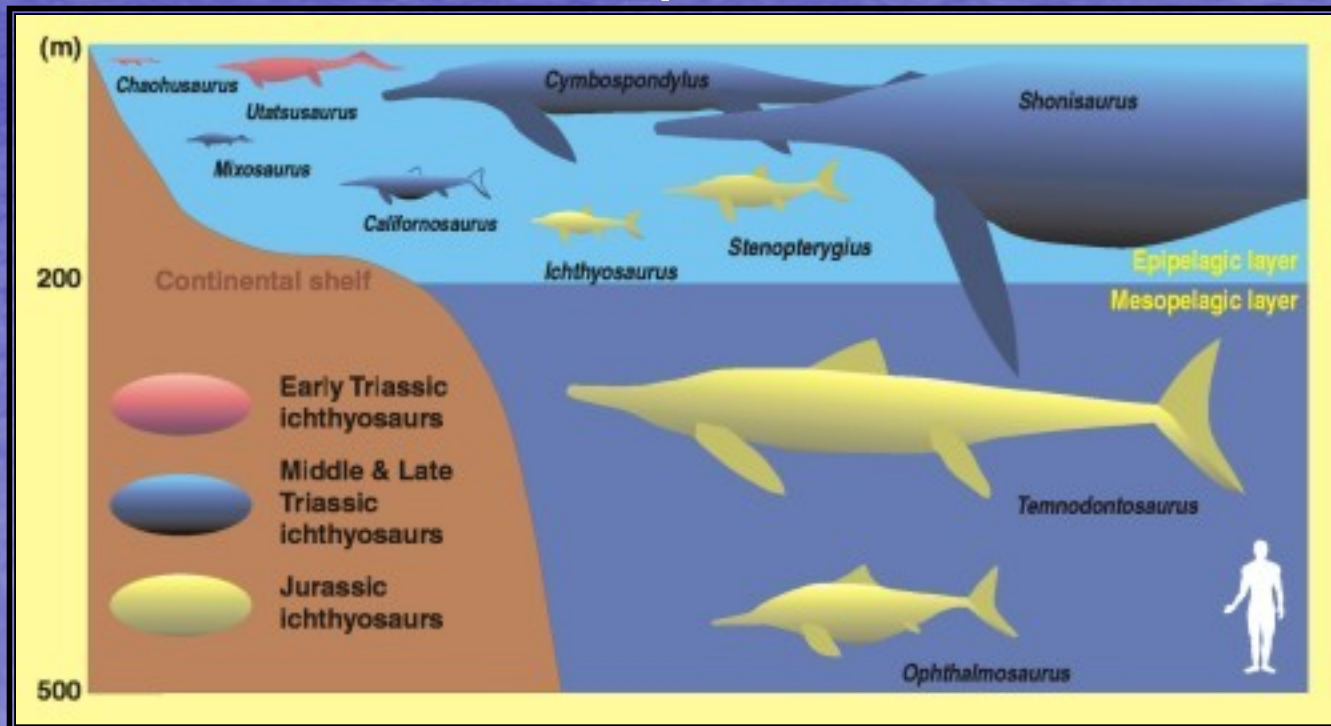
Ichthyosaur Taxonomy

- Recent studies place ichthyosaurs as an outgroup to Sauria and within Neodiapsida



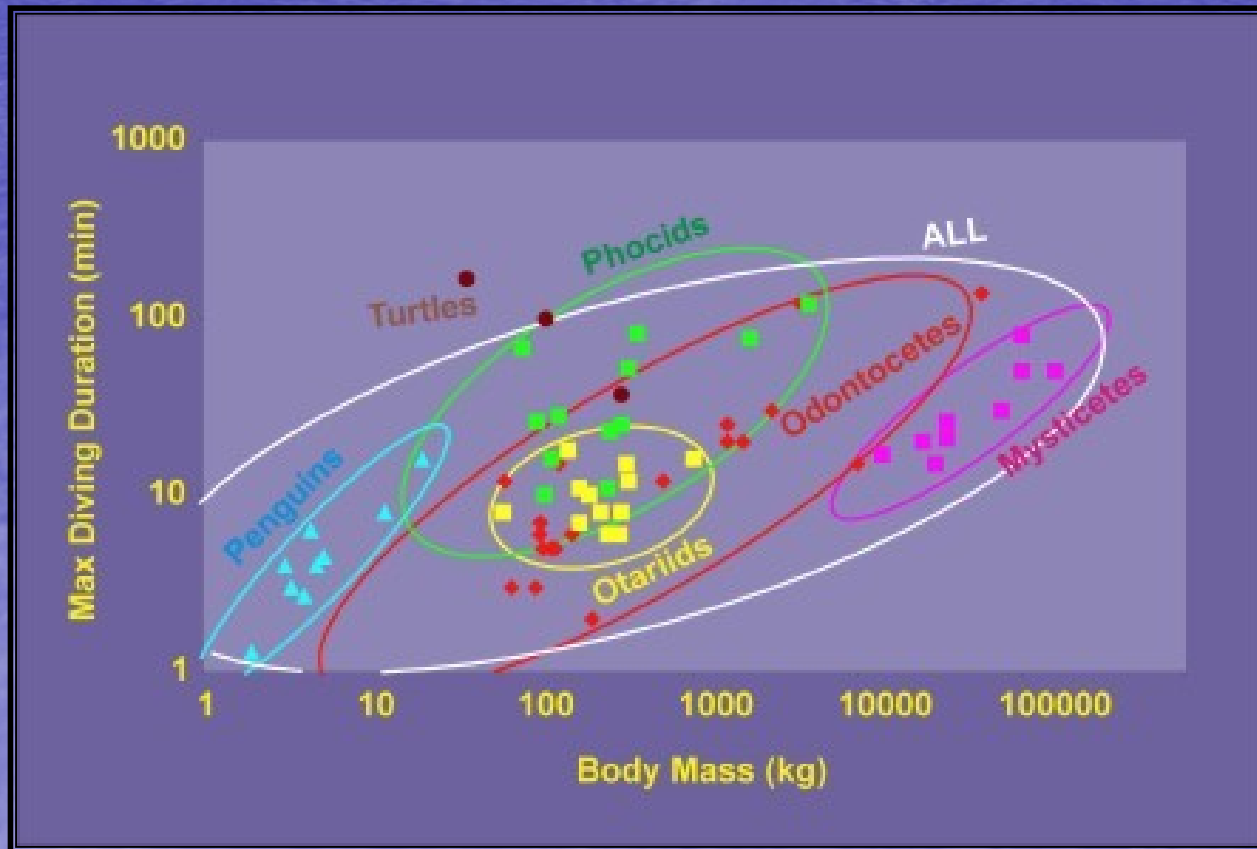
Ichthyosaur Ecology

- Belemnite squid hooks found in ichthyosaur stomachs indicate mainly squid diet, with some fish and other marine animals
- Some later ichthyosaurs filled deep water diving niches, but occasionally suffered from “the bends”



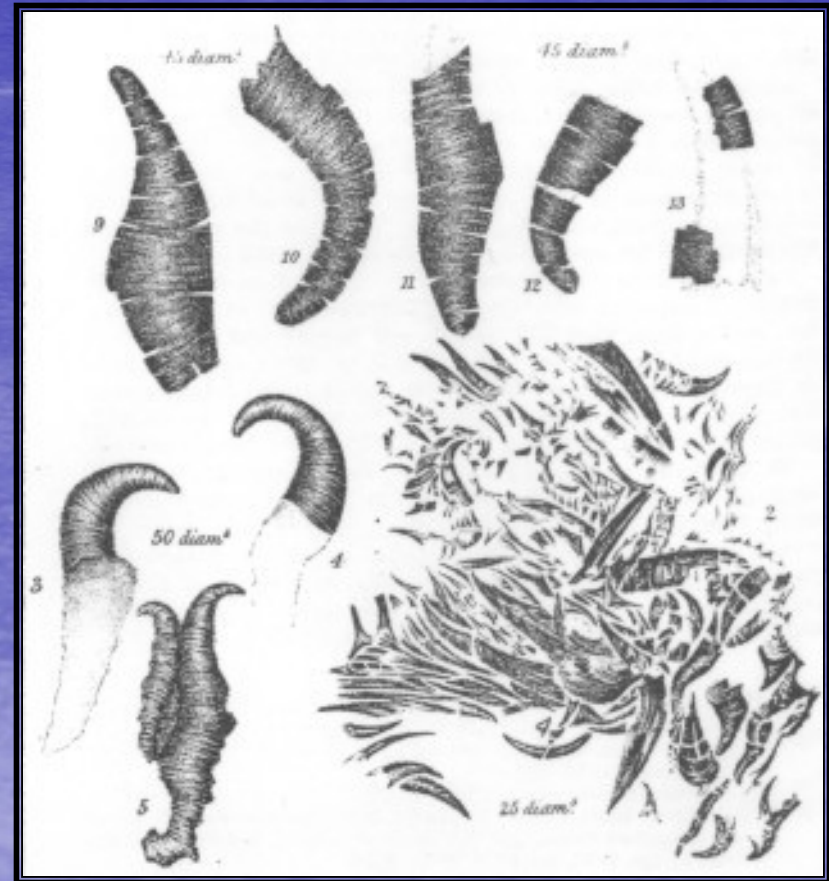
Ichthyosaur Ecology

- We can estimate body mass from models, and determine diving duration



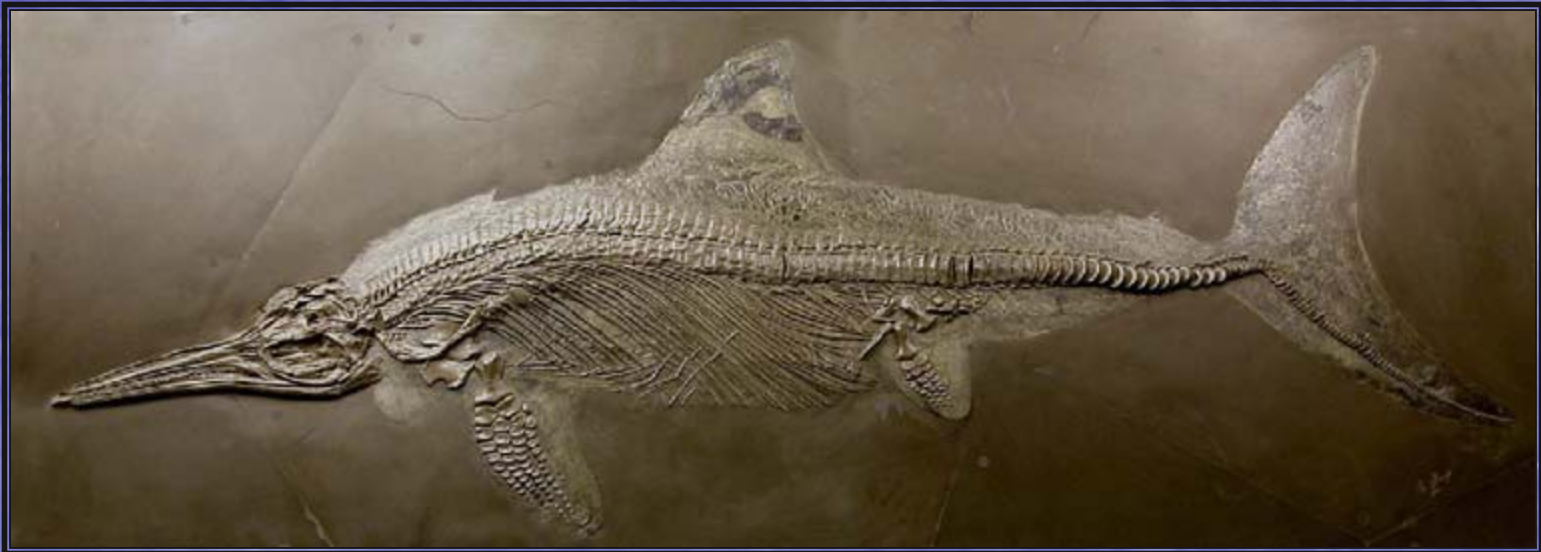
Ichthyosaur Ecology

- Since ichthyosaurs were first discovered, small structures have been found within their body cavities
- Originally thought to be scales, they are actually squid hooks and beaks (belemnites)



Ichthyosaur Taphonomy

- Ichthyosaurs are some of the best preserved fossils of all
- Skin impressions are so fine that we can see fibrous structures that supported a stiffened dorsal and caudal fin

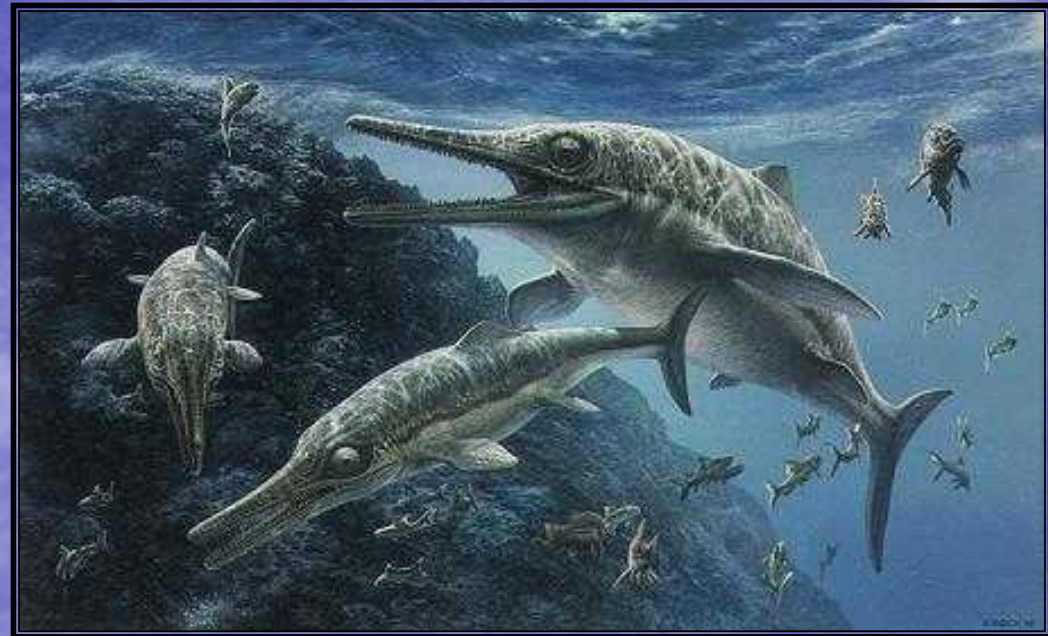
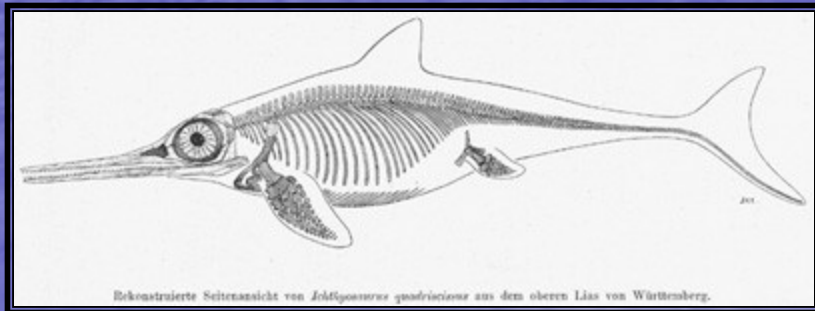


Jurassic Ichthyosaurs



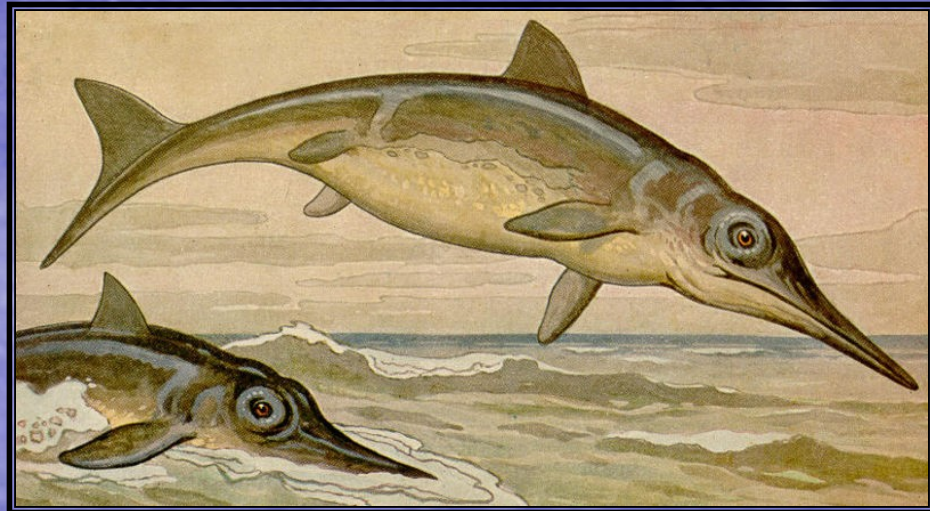
Jurassic Ichthyosaurs

- Early Jurassic record shows dominance of fish-shaped form in the “true” ichthyosaurs such as *Ichthyosaurus*, *Temnodontosaurus*, *Eurhinosaurus*, and *Stenopterygius*.
- Many died out in Middle Jurassic, with just a few clades in the Late Jurassic.

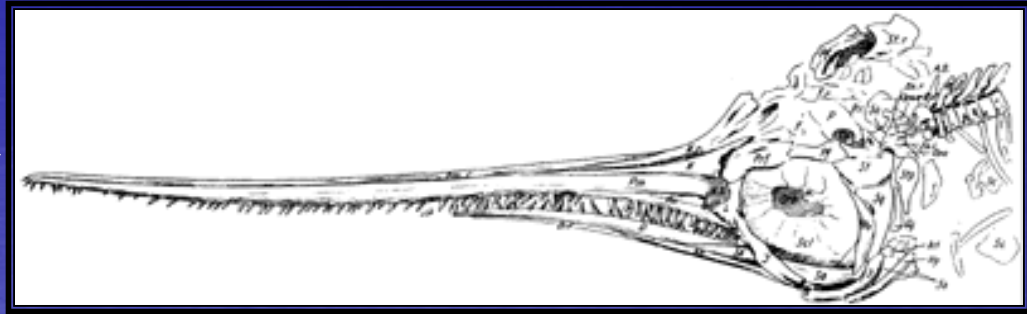


Ichthyosaurus

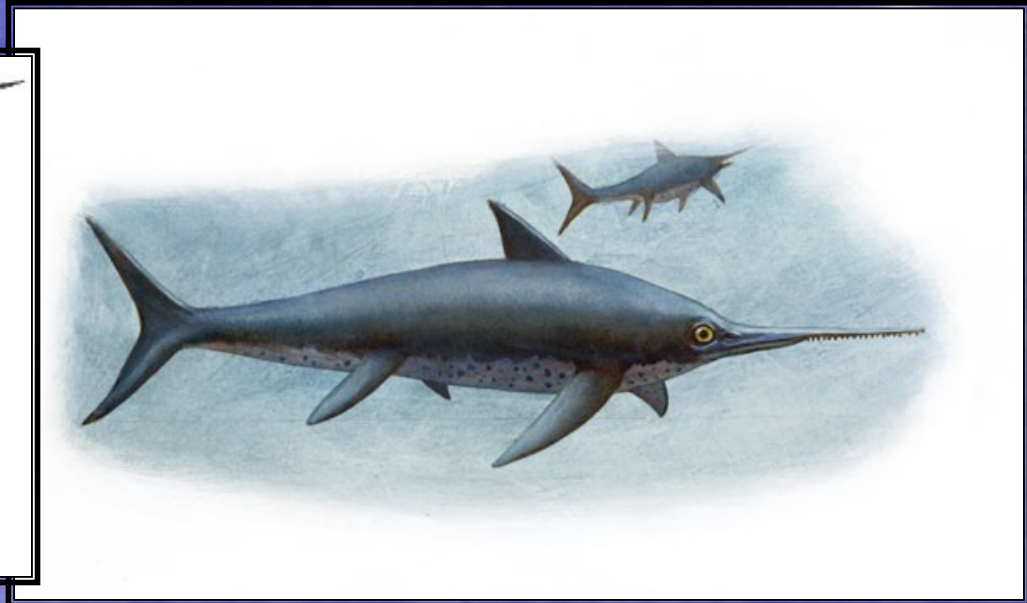
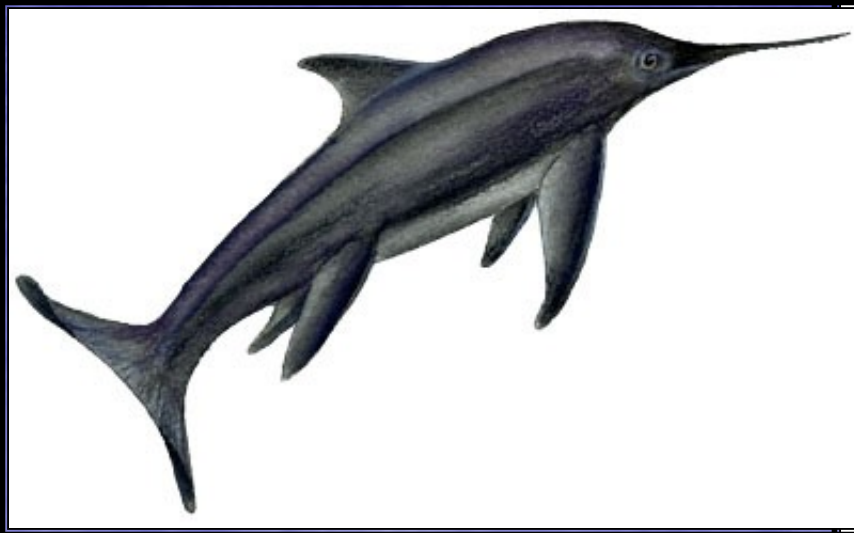
- Type species with typical fish-like body
- From here on out, ichthyosaurs become increasingly thunniform
- Lived through the Early Jurassic



Eurhinosaurus



- Jurassic ichthyosaur with an elongated rostrum and sideways teeth, much like the modern sawfish
- May have been for hunting benthic yummmies on the sea floor, or for fighting



Stenopterygius

- Similar to *Ichthyosaurus*, *Stenopterygius* specimens have been found with young exiting the birth canal, indicating that ichthyosaurs were viviparous and gave birth tail first, like cetaceans



Temnodontosaurus

- Also known as *Leptopterygius*, this large (30 feet) Late Jurassic ichthyosaur had the largest eyes of any vertebrate
- Likely occupied deeper waters hunting squid, ammonites, and possibly other ichthyosaurs in the darker water



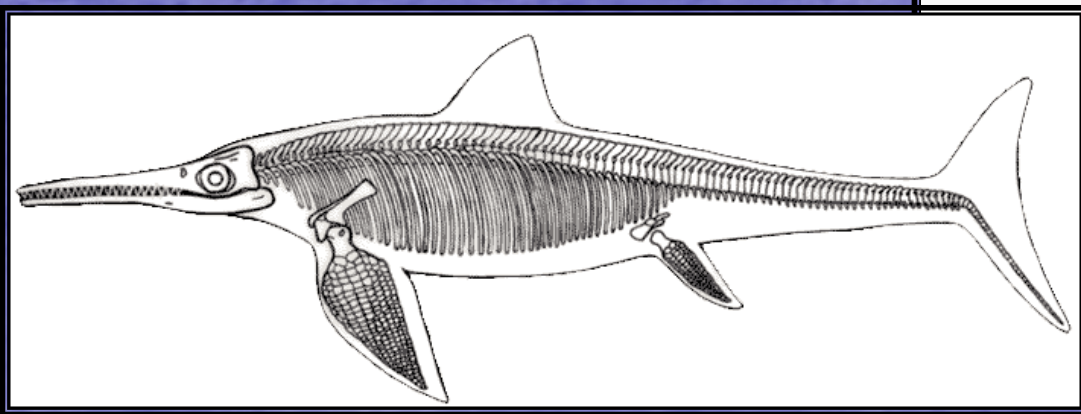
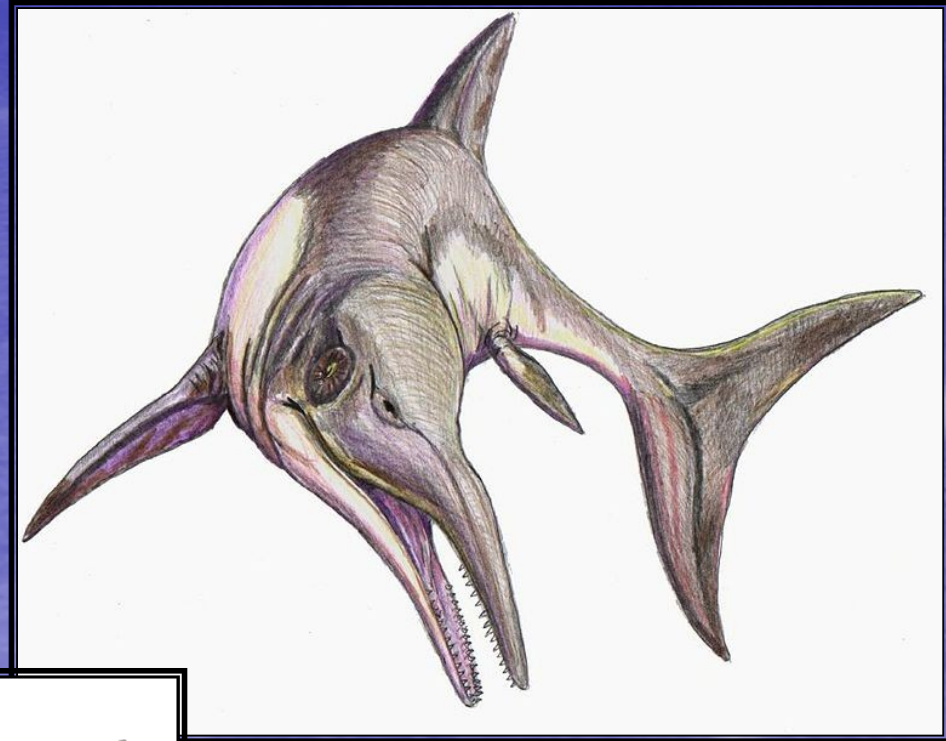
Ophthalmosaurus

- Large eyes for body size (with sclerotic ring to match) and nearly toothless jaw indicates hunting for deep squid
- Gave birth to litters of pups
- Could swim at estimated speeds of 2.5 m/s



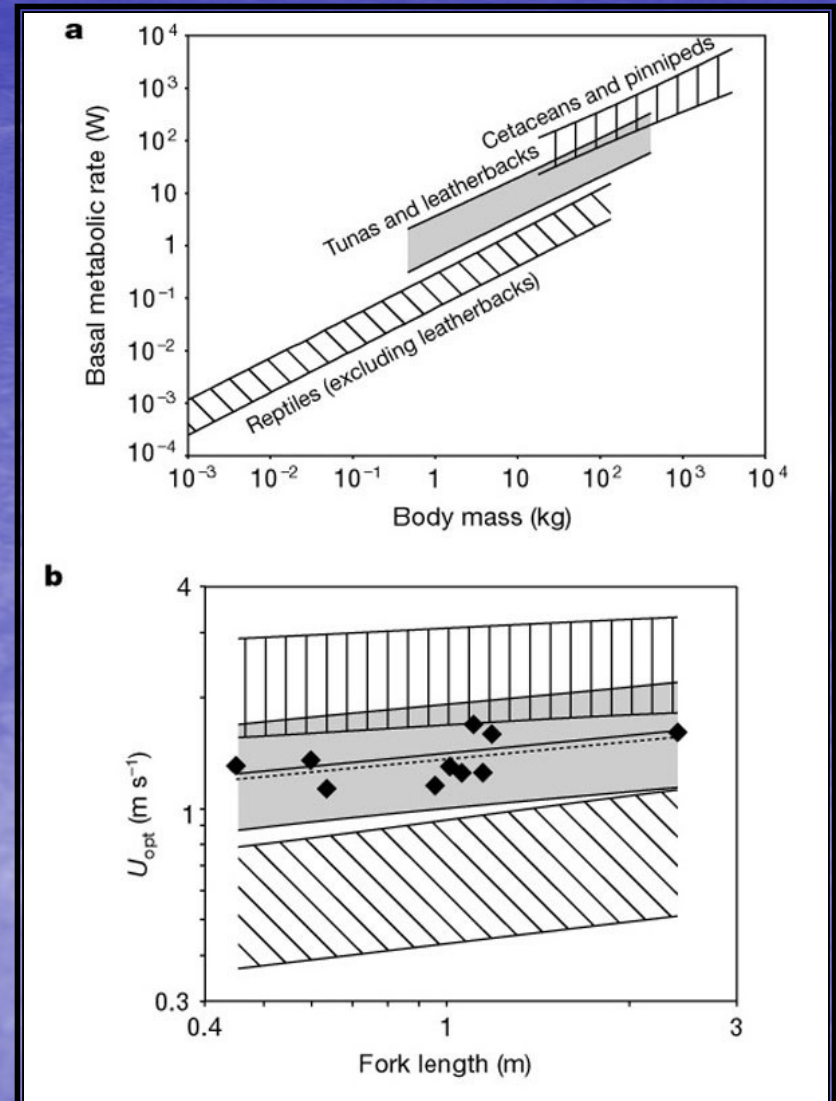
Cretaceous Ichthyosaurs

- Only *Platypterygius* lasted into the Cretaceous (in NA)
- Had extra digits in forelimb, with large homocercal tail



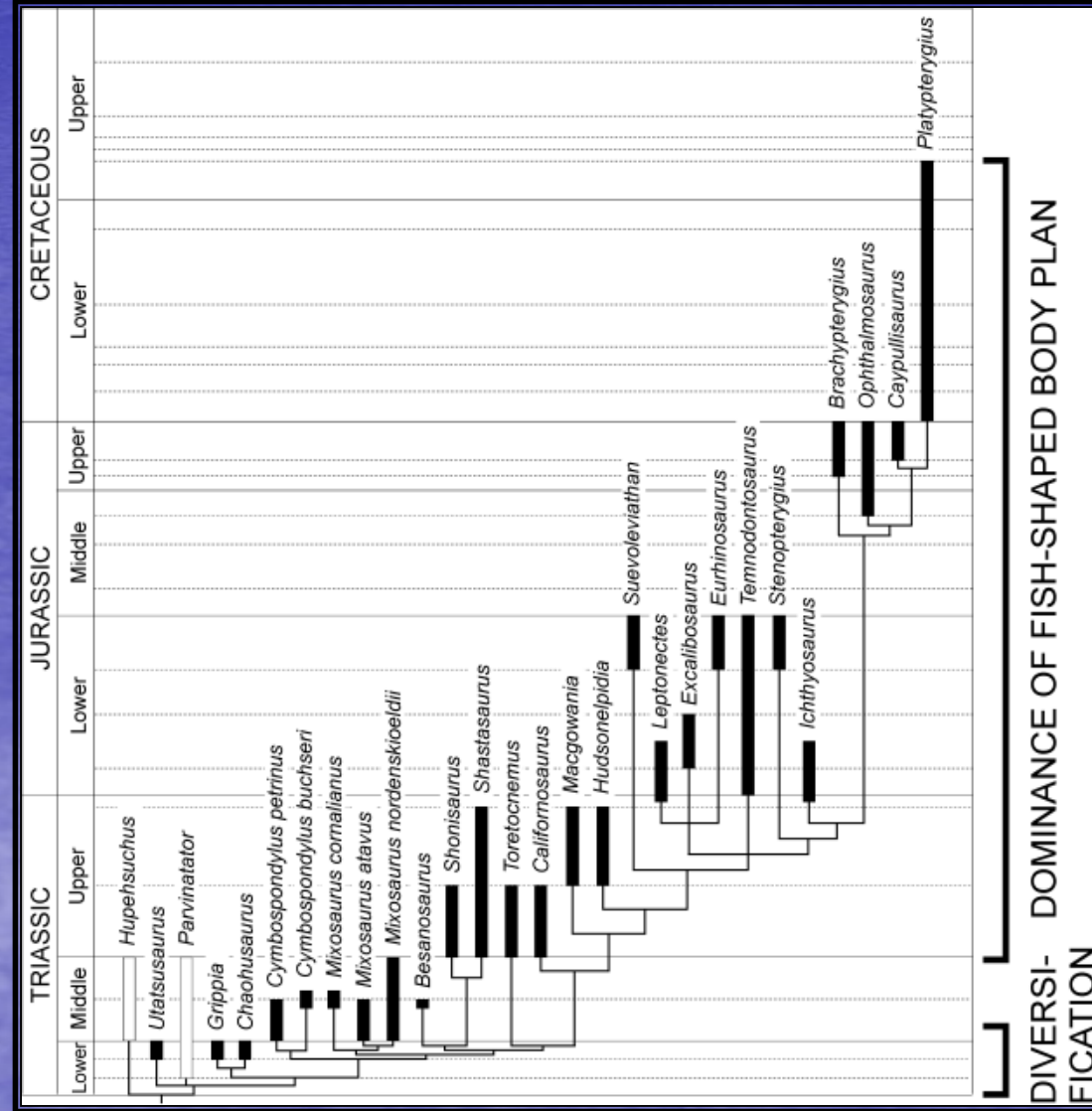
Ichthyosaur Locomotion

- Using estimations of metabolic rates and masses, we can calculate proposed swimming speeds for ichthyosaurs to be up to 25 mph (the fastest cetacean is 34)



Ichthyosaur extinction

- By the Middle Jurassic, ichthyosaurs had decreased diversity to one clade (Ophthalmosauria)
- One genus remained into the Cretaceous, and died out in the mid-Cretaceous extinction event (that also killed off some large pliosaurus)
- Likely out-competed by new Teleost fishes (*Xiphactinus*) and ambush strategies of mosasaurs



Next Week:

- Basal Sauropterygia
- Plesiosaurs
- Basal Pliosaurus