

## Does Evolution Make Big Changes?

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## 150 years after the “Origin”

- ▶ Most modern evolution skeptics acknowledge that evolution makes small changes
- ▶ They maintain that it does *not* make new families, classes, and phyla.
- ▶ Each of these were created separately.

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## Progressive Creationism

In 1982, Millard Erickson (a baptist theologian) proposed that

- ▶ God created many kinds of plant and animal,
- ▶ then let them evolve.
- ▶ Species evolve, but only in small ways.
- ▶ Big differences reflect separate creation

This idea now prominent among evolution skeptics in the USA.

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## Idea goes back at least to 1931

It may be held that each kingdom originated is a separate creation, or that each phylum, or class, or order, or family, or genus, is an independent creation, which may have undergone differentiation or evolution since its creation.

(Dewar, 1931. *Difficulties of the Evolution Theory*, p. 5)

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## And was discussed in 1866

No doubt, any number of intermediate hypotheses might be framed, imagining separate ancestors for every genus, every order, every class, and so on. But in point of fact, no one does attempt these compromises.

(J.J. Murphy, 19 Nov 1866. *Northern Whig*

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“Science shows that whether they are vertebrates (finches), invertebrates (walking sticks), or even bacteria—any observed change is minor and horizontal in nature, with no net increase in genetic information leading to large (vertical) change, or macroevolution.”

Frank Sherwin (2003)

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How can we tell?

- If evolution never makes big changes, then
- ▶ There should be no intermediate fossils linking major taxa.
  - ▶ Similar organisms should show traces of common descent, since they had a common ancestor.
  - ▶ Dissimilar organisms should not show such traces.
- Let us take these predictions one at a time.

Whales

- ▶ aquatic
- ▶ no visible hind limbs
- ▶ yet they are mammals
- ▶ until recently, no transitional fossils

Why the lack of transitional fossils?

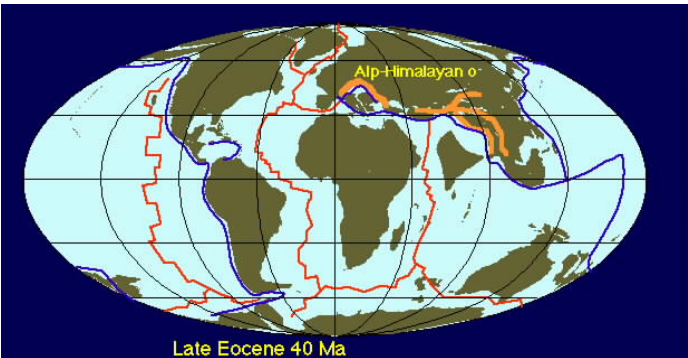
“Such major discontinuities [as that between terrestrial mammal and whale] simply could not, unless we believe in miracles, have been crossed in geologically short periods of time through one or two transitional species occupying restricted geographical areas (Denton, 1986, p. 193).”  
Denton argued that if whales evolved from land mammals, the intermediates ought to exist.

Is it even plausible that land mammals could evolve into whales?

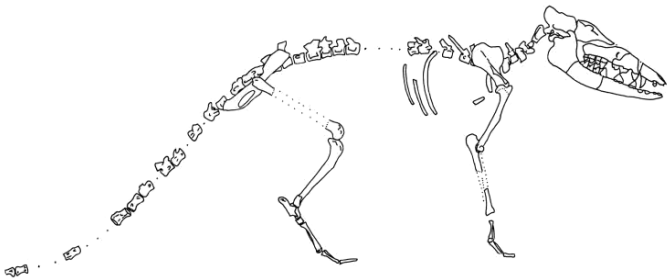
“The gradual transformation of a land animal into a whale or a sea-cow appears to be physically impossible, because the tail could not act as a propeller by vertical motion until the pelvis had been so reduced in size as to render locomotion on land impossible. If such transformation occurred gradually there must have been a long period when the ancestors of these aquatic forms, while yet poor swimmers, were unable to use the hind limbs for locomotion. How could such creatures hold their own in the struggle for existence?”

(Dewar, 1931)

The Eocene World



*Pakicetus*, a terrestrial whale



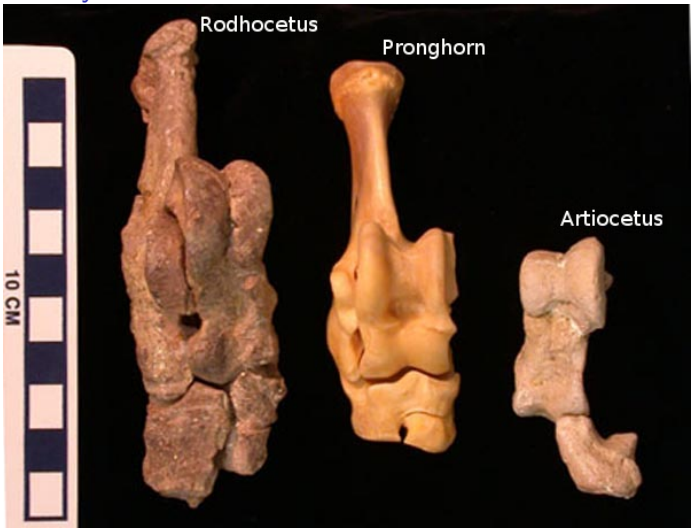
- ▶ Lived along shore of Tethys 50 Mya (in modern Pakistan)
- ▶ Toes end in hooves
- ▶ Ankle of an artiodactyl (like sheep, deer, cow)
- ▶ Ear and skull of a whale

Involucrum



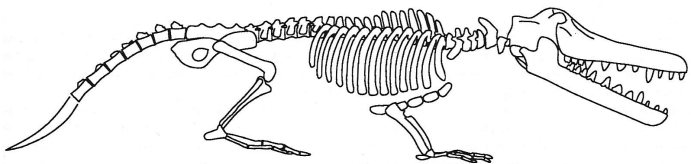
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Artiodactyl ankles



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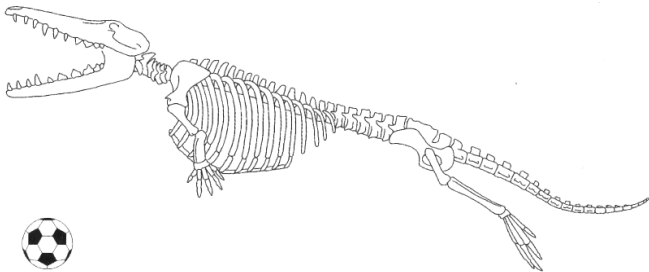
Ambulocetus, an amphibious whale (49 Mya)



- ▶ Pakistan
- ▶ ambush predator like crocodile
- ▶ hooves and ankles of artiodactyl
- ▶ head and ears of whale
- ▶ short legs
- ▶ swam by paddling with enormous feet

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Ambulocetus



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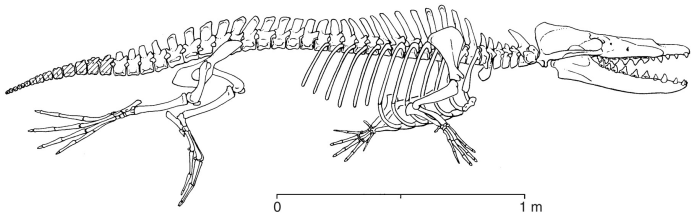


Ambulocetus

An ambush predator.

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Rodhocetus (amphibious, 46–47 Mya)



- ▶ Pakistan
- ▶ legs even shorter—awkward on land
- ▶ hooves and ankles of artiodactyl
- ▶ skull and ears of whale
- ▶ swam using powerful tail (longer than shown)

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*Rodhocetus* in life



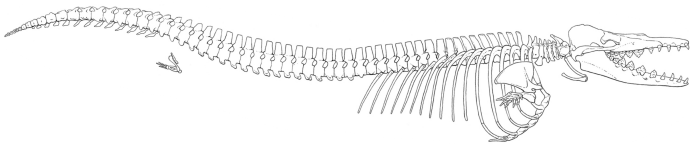
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*Maiacetus*

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*Dorudon*, an aquatic whale (40 Mya)



- ▶ tropical oceans worldwide
- ▶ flippers
- ▶ looked like porpoise
- ▶ but with small, functional hind legs, feet, and toes

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*Dorudon* in life



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Why did it take us so long to find these whales?

*Indohyus*

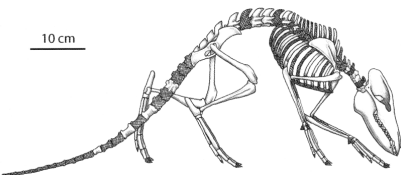
Contemporary with *Pakicetus*.

Fully terrestrial artiodactyl.

But ear had involucrum, as in whales.

- ▶ found only in Pakistan
- ▶ only during 10 million years

You had to look in just the right place, and in rocks of just the right age.



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Fossil whale localities

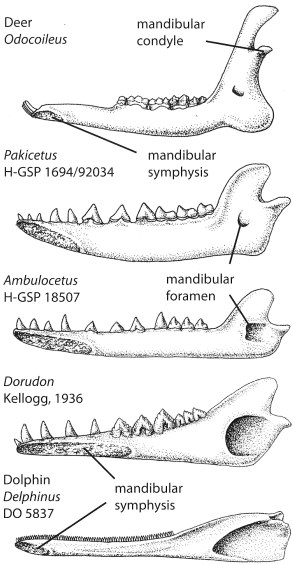


Oxygen isotopes in bones

MODERN CETACEANS	habitat	oxygen isotope values ( $\delta^{18}O_p$ )
oceanic dolphins (n = 11) killer whale (n = 1) sperm whale (n = 2)	marine	
Indian river dolphin (n = 1) Chinese river dolphin (n = 1) South American river dolphin (n = 1)	freshwater	
EOCENE CETACEANS	sediment	
protocetid whale (n = 3) remingtonocetid whale (n = 2)	ocean floor	
Attockicetus (n = 1) Ambulocetus (n = 8)	coastal	
pakicetid whales (n = 11)	riverbed	

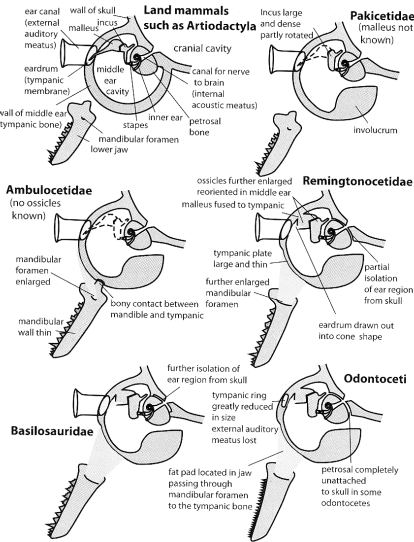
Oxygen isotopes in bones

- ▶ distinguish freshwater from ocean mammals.
- ▶ Early whales lived in freshwater.
- ▶ Later whales lived in ocean.
- ▶ Ambulocetus was transitional.



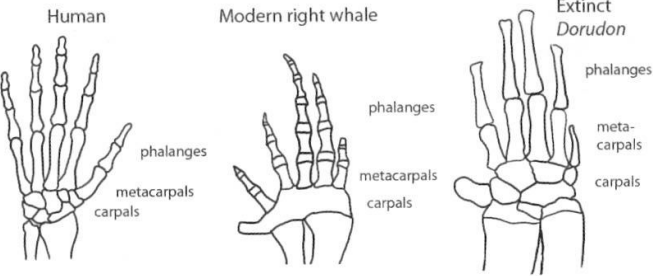
Evolution of mandibular foramen

- Transmits sound in whales.
- Gradual increase in size.
- Gradual improvement in underwater hearing.

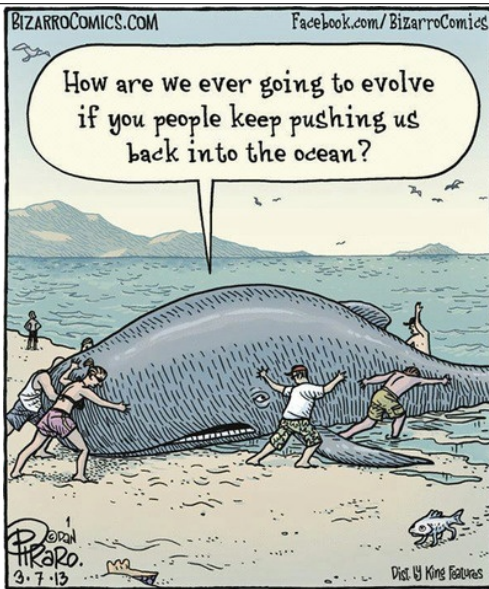


- Middle ear becomes isolated from skeleton.
- Gradual improvement in underwater hearing.

Whale hands

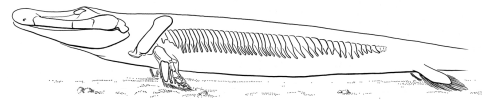


Homology: known since the 19th century.

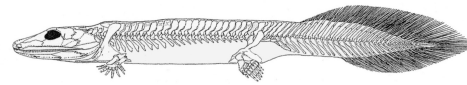


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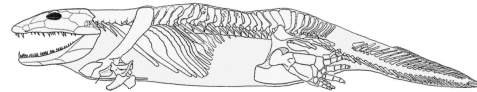
## Intermediates between fish and amphibians



Tiktaalik (375 Mya) (Daeschler, Shubin, & Jenkins)



Acanthostega (365 Mya) (Ahlberg, Erik & Clack)



Ichthyostega (362.5–367 Mya) (Ahlberg, Erik & Clack)

- ▶ Tiktaalik: fish with shoulder girdle, elbow, and wrist.
- ▶ Acanthostega: hands with 8 fingers; tail of fish
- ▶ Ichthyostega: Amphibian w/ fin rays in tail

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## Walking lungfish



During Devonian, tetrapods evolved from a group that includes lungfish.

It was thought that walking evolved in early tetrapods.

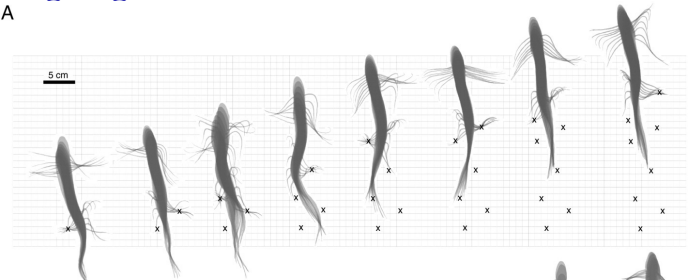
But modern African lungfish walk underwater on narrow fins.

Walking may have evolved before the move to land.

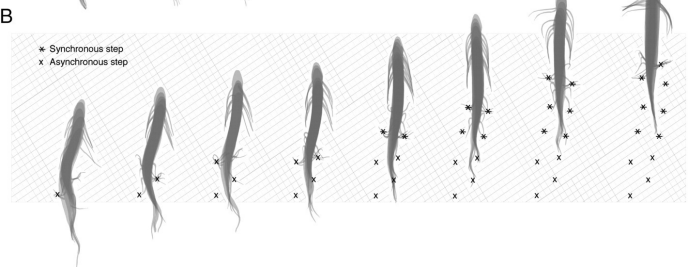
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## Walking lungfish

A

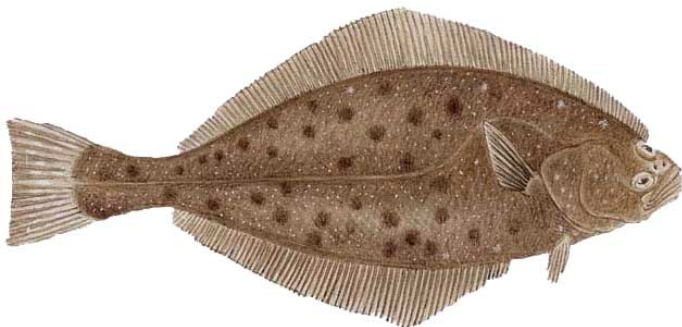


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## Pacific halibut



Both eyes on same side.

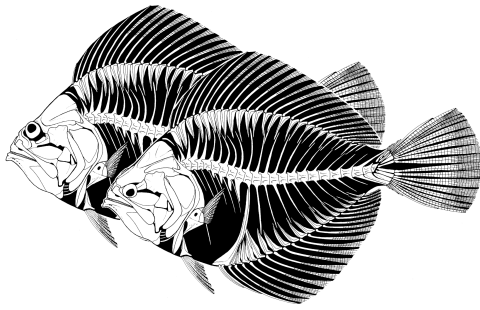
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### St. G. Mivart (1869)

- ▶ Imagine a normal fish lying on its side in the sand.
- ▶ A mutation slightly moves lower eye.
- ▶ Not beneficial: eye still faces down.
- ▶ Flatfish eyes cannot have evolved by natural selection.

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Matt Friedman (2008)

- ▶ Transitional flatfish (45 my old)
- ▶ Eyes asymmetrical
- ▶ Still on opposite sides of head.
- ▶ Flatfish evolved gradually.

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Archaeopteryx  
(Jurassic)

- ▶ wings with feathers
- ▶ wish bone of bird
- ▶ jaws, teeth, tail of dinosaur

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## Feather of Berlin Archaeopteryx



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## Summary of fossil evidence

- ▶ Transitional fossils document evolution of:
  - ▶ whales from artiodactyls
  - ▶ asymmetrical eyes of flatfish
  - ▶ birds from dinosaurs
  - ▶ tetrapods from fish
- ▶ What about all the other transitions?
- ▶ To find out, we turn to a different form of evidence.

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