topic 10 – Origins of Cetaceans

I. Cetaceans

A. Cetaceans are mammals

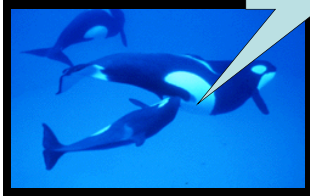
-warm-blooded

-breathe air via lungs

-live young*

-mammary glands

Baby cetaceans swim on side, nurse from nipples concealed in abdominal mammary slits



topic 10 – Origins of Cetaceans

I. Cetaceans

A. Cetaceans are mammals

-warm-blooded

-breathe air via lungs

-live young

-mammary glands

-hair (snout, chin, behind blow hole)

-up-down spinal movement and mobility

topic 10 – Origins of Cetaceans

They are not fish:

e.g., tail ("fluke") and mobility of cetaceans

Fluke of a humpback whale

Tail fin of a yellow-taill snapper

topic 10 – Origins of Cetaceans

They are not fish:

e.g., blowhole

sperm whale surfacing

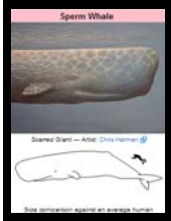
sperm whale starts to exhale just below surface

topic 10 – Origins of Cetaceans

I. Cetaceans

B. Two types

1. Toothed whales

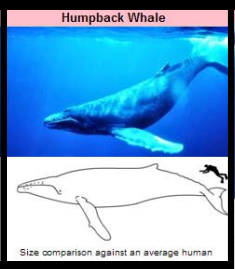


topic 10 – Origins of Cetaceans

I. Cetaceans

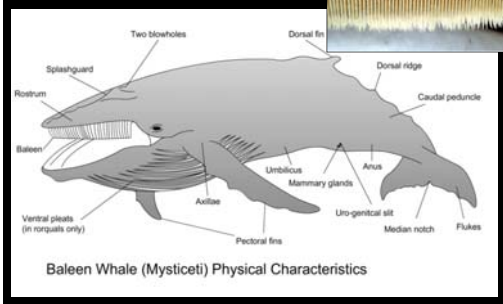
B. Two types

2. Baleen whales



topic 10 – Origins of Cetaceans

Baleen whales



Baleen = in two parallel rows of plates from upper
jaw = modified epidermis = keratin (stiff, elastic)
plus hydroxyapatite (bony mineral)

topic 10 – Origins of Cetaceans

II. Evolutionary origins

topic 10 – Origins of Cetaceans

II. Evolutionary origins

1. Phylogenetic evidence

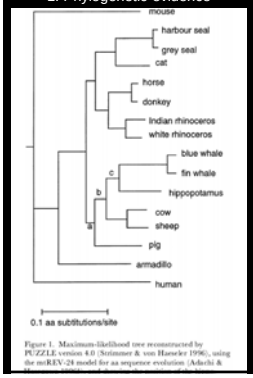


Figure 1. Maximum-likelihood tree reconstructed by PUZZLE version 4.0 (Strimmer & von Haeseler 1996), using the mtREV-24 model for aa sequence evolution (Adachi &

Hippos are the last of a mammal group that thrived for 40 million years

topic 10 – Origins of Cetaceans

II. Evolutionary origins

1. Phylogenetic evidence
2. Independent examples of terrestrial >> aquatic transitions in animals

topic 10 – Origins of Cetaceans

II. Evolutionary origins

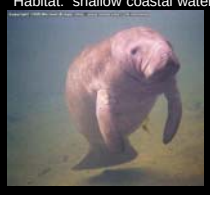
1. Phylogenetic evidence
2. Independent examples of terrestrial >> aquatic transitions in animals

a. cetaceans b. sirenians c. pinnipeds d. otters

topic 10 – Origins of Cetaceans

<u>b. sirenians</u>
Evolved from protoungulates, related to elephants, aardvarks, etc.
ca. 40 Ma

<u>Dugongs</u> = shallow coastal waters of Indo-Pacific.
<u>& Manatees</u> = shallow costal waters & rivers of Caribbean, Amazon, West Africa.
Hind legs lost, but foreflippers have remained pliable for maneuvering.
Habitat: shallow coastal waters, freshwater rivers.



topic 10 – Origins of Cetaceans
II. Evolutionary origins

c. Pinnipeds ("fin-feet" or "wing-feet")
Evolved from "bear-like", carnivore ancestors ca. 30 Ma

Seals, sea lions, and walruses

Bull elephant seals, CA, USA

topic 10 – Origins of Cetaceans
II. Evolutionary origins

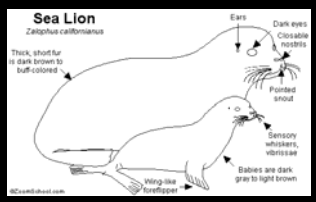
Notice any similarities with the feet of terrestrial mammals? (Bull elephant seals, CA, USA)

topic 10 – Origins of Cetaceans
II. Evolutionary origins

Sea lions

topic 10 – Origins of Cetaceans

II. Evolutionary origins



CA sea lion

topic 10 – Origins of Cetaceans

II. Evolutionary origins

Walrus

Pacific Walrus

topic 10 – Origins of Cetaceans

II. Evolutionary origins

d. Otters (13 spp.)

Related to badgers, weasels, polecats; evolved ca. 5-7 Ma

Least streamlined of marine mammals.

Hind feet >> flippers, front limbs are those of terrestrial carnivore.

Pacific sea otter

topic 10 – Origins of Cetaceans

II. Evolutionary origins

d. Otters (13 spp.)

Related to badgers, weasels, polecats; evolved ca. 5-7 Ma

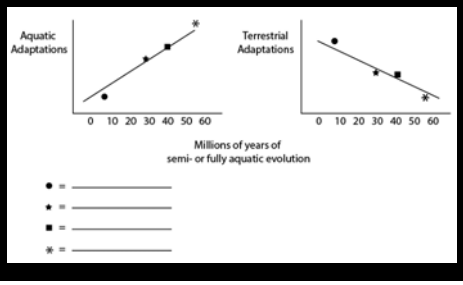
Least streamlined of marine mammals.

Hind feet >> flippers, front limbs are those of terrestrial carnivore.

Northern river otter

Characters under selection during evolution

1. Hairiness
2. Subcutaneous blubber/fat
3. Nostril Position
4. Front limbs (toes, claws)
5. Hind limbs
6. Fluke development

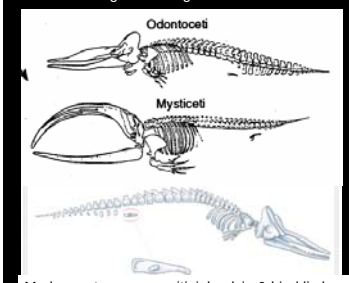


	Otters (5-7 Ma)	Pinnipeds (30 Ma)	Sirenians (40 Ma)	Whales (50 Ma)
1. Amount of hair	Thick coat; whiskers	Very sparse; whiskers	Very sparse; whiskers poorly developed	Very very sparse; no whiskers
2. Nasal position	Front	High Front	High Front	Top
3. Front limbs, toe development	Well	Fair	Non-existent	Non-existent
4. Nails/claws in feet	Well	Fair	Non-existent	Non-existent
5. Hind limbs as flippers	Yes	Yes	--	--
6. Blubber/fat as insulation	Poor	Fair	Well	Well

topic 10 – Origins of Cetaceans

II. Evolutionary origins

1. Phylogenetic evidence
2. Independent examples of terrestrial >> aquatic transitions in animals
3. Front limbs >> flippers
4. Hind legs >> no legs



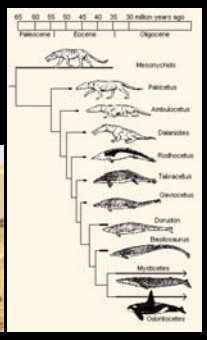
Modern cetaceans: vesitigial pelvis & hind limbs: occasional atavisms

topic 10 – Origins of Cetaceans

II. Evolutionary origins

Fossil evidence

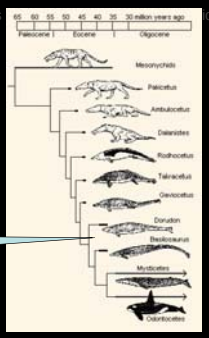
Valley of the Whales
(150 km S of Cairo)



topic 10 – Origins of Cetaceans

II. Evolutionary origins

1. Phylogenetic evidence
2. Independent examples ons in animals
3. Front limbs >> flippers
4. Hind legs >> no legs

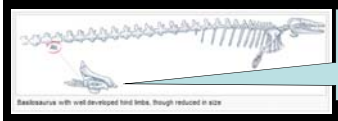


basilosaurids & dorudontids

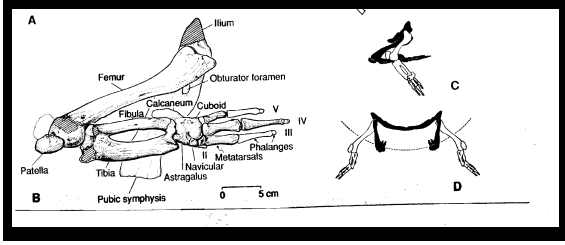
topic 10 – Origins of Cetaceans

II. Evolutionary origins

4. Hind legs >> no legs : basilosaurids and dorudontids (ca. 40-30 Ma)



Basilosaurus had 2 tiny legs, probably used as claspers when mating.



topic 10 – Origins of Cetaceans

II. Evolutionary origins

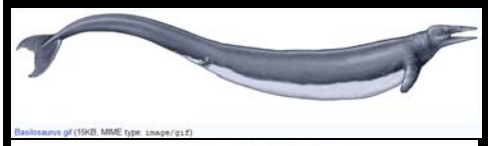
4. Hind legs >> no legs : basilosaurids and dorudontids (ca. 40-30 Ma)

Durodon, had 2 tiny legs, probably used as claspers when mating.

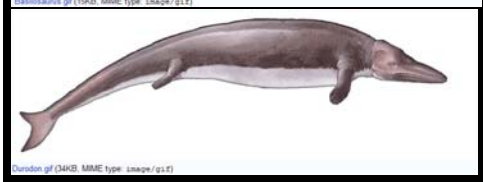
topic 10 – Origins of Cetaceans

II. Evolutionary origins

4. Hind legs >> no legs : basilosaurids and dorudontids (ca. 40-30 Ma)



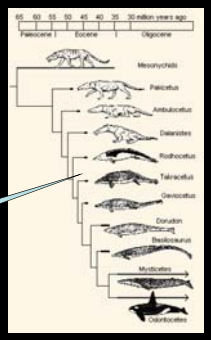
Basilosaurus.gif (15KB, MIME type: image/gif)



Durodon.gif (34KB, MIME type: image/gif)

topic 10 – Origins of Cetaceans

II. Evolutionary origins

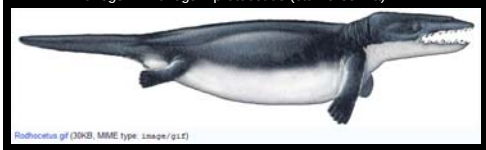


protocetids

topic 10 – Origins of Cetaceans

II. Evolutionary origins

4. Hind legs >> no legs : protocetids (ca. 45-35 Ma)



e.g., *Rodhocetus*: fore and hind limbs could support body on land but articulation show adaptations for swimming.
Therefore, likely to have been amphibious.

Unclear at present if they had flukes.

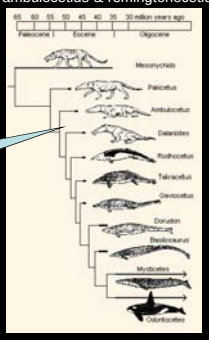
Doubled-pulleyed Astragalus of *Rodhocetus* and *Artiocetus (pronghorn in middle)*

topic 10 – Origins of Cetaceans

II. Evolutionary origins

4. Hind legs >> no legs : ambulocetids & remingtonocetid (ca. 50-40 Ma)

ambulocetids & remingtonocetids



topic 10 – Origins of Cetaceans

II. Evolutionary origins

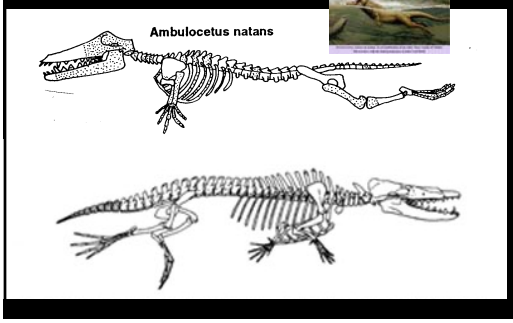
4. Hind legs >> no legs : ambulocetids & remingtonocetid (ca. 50-40 Ma)

Ambulocetus natans in action. A reconstruction of an early close cousin of whales. Shown here with the kind permission of artist Carl Buell

topic 10 – Origins of Cetaceans

II. Evolutionary origins

4. Hind legs >> no legs : ambulocetids & remingtonocetid (ca. 50-40 Ma)



topic 10 – Origins of Cetaceans

II. Evolutionary origins

4. Hind legs >> no legs : ambulocetids & remingtonocetid (ca. 50-40 Ma)

Kutchicetus.jpg (29KB, MIME type: image/jpeg)

The Remingtonocetid *Kutchicetus*: an artist's impression.

topic 10 – Origins of Cetaceans

II. Evolutionary origins

1. Phylogenetic evidence
2. Terrestrial >> aquatic
3. Front limbs >> flippers
4. Hind legs >> no legs
5. Nostril migration