Palaeontology

Lecture 10

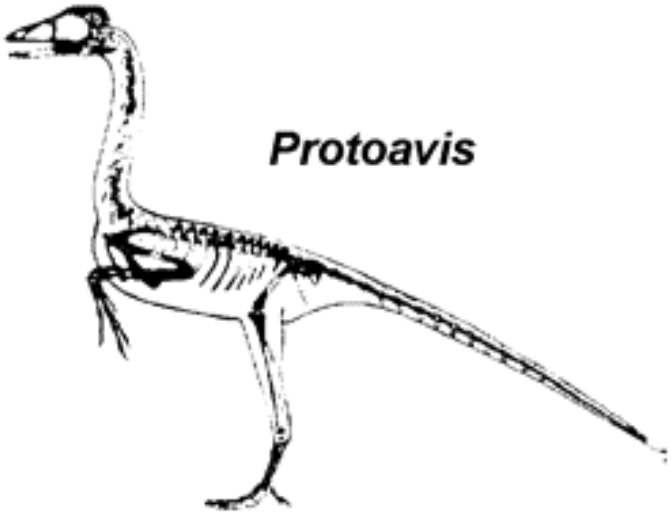
Animal Kigdom: Mammals, Hominids

Aves

- Endothermic animals, with wings and feathers, they possess a beak and lay eggs. Most fly but not all.
- Bird bones are thin and hollow, thus their preservation is difficult.
- Two views for their ancestry, either from theropod dinosaurs, or primitive archosaurs (both bipedal)
- However, there are several theropods with feathers, hollow and thin bones, and carinated sternum.

Protoavis

Found in the L. Triassic of Texas and considered as the connection with the Lower archosaurs and for some ancestor of the birds.



Class Aves

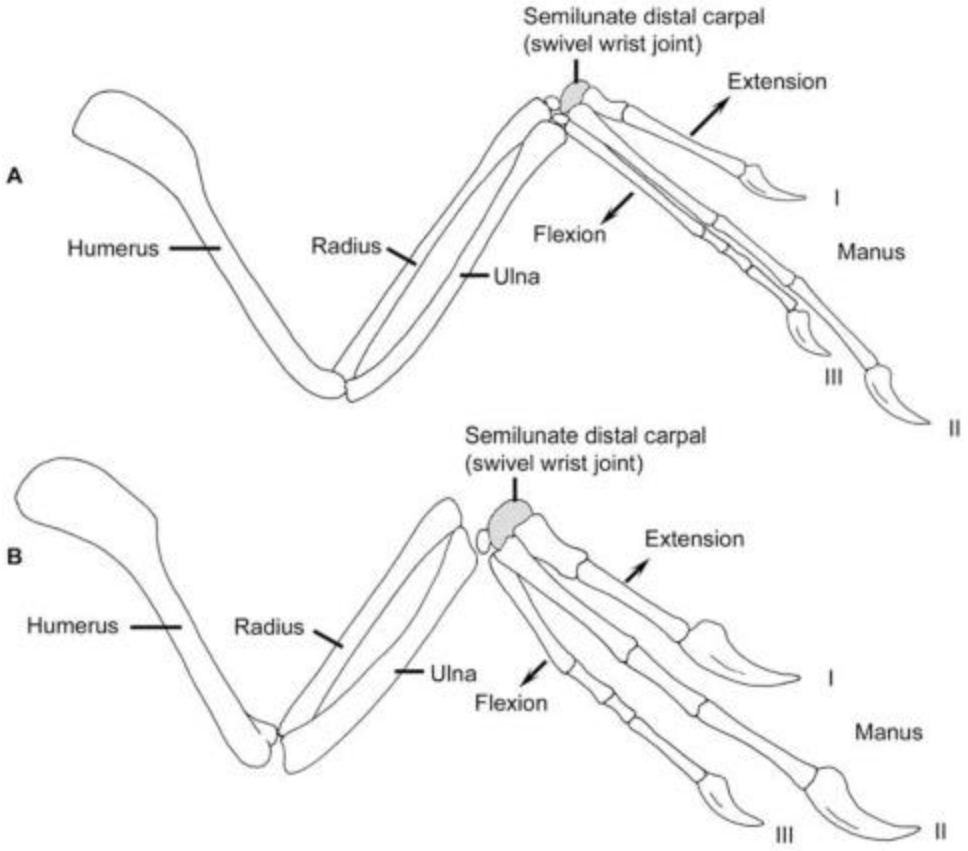
- The feathers evolved from the reptile scutes. Originally they were used for insulation, camouflage, showing of and not for flight.
- It has been proposed that the birds are connected with the dinosaurs and that they should be placed together in the Class Dinosauria. This is not widely accepted yet.

Archaeopteryx

- The most known fossil is *Archaeopteryx*, which although not the older it was the first one.
- It was found in a 150 my Jurassic limestone in Solnhofen Germany in 1861.
- Since then 12 specimens have been found.
- It possesses some bird and some reptile features (Transitional fossils).

Archaeopteryx

- Bird features:
  - Feathers
  - Wings
- Reptile features:
  - Theropod like skeleton
  - teeth
  - Long tail like a lizzard
  - Front limbs with nails
  - From the breastbone the carina is missing, which means that it didn’t have strong muscles for a long flight.



Archaeopteryx

Deinonychus

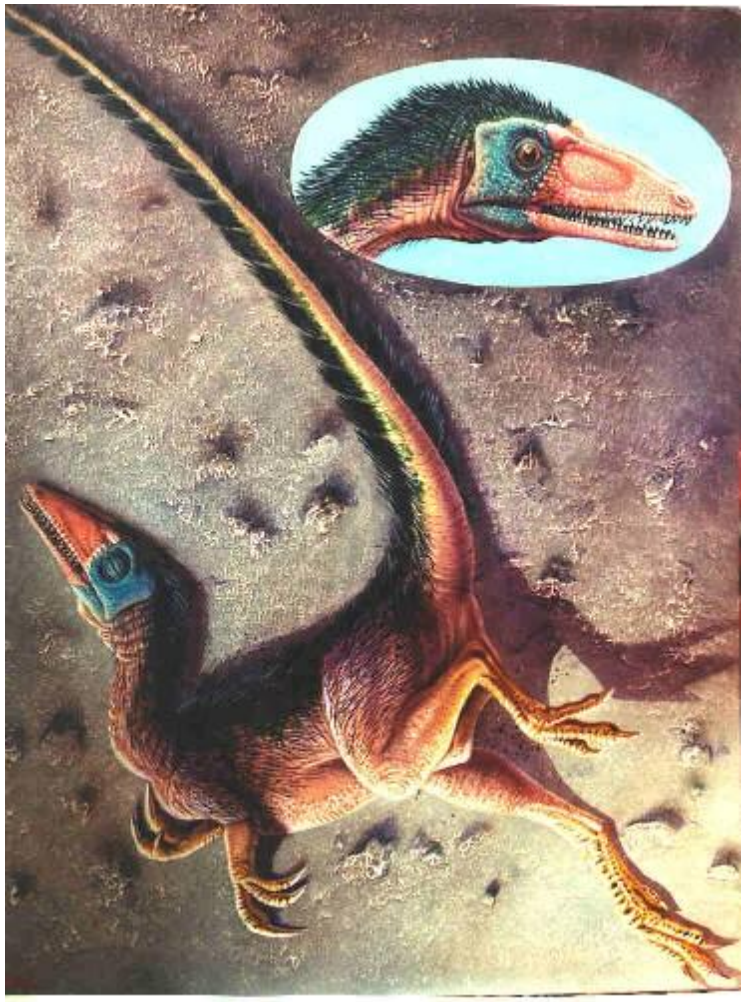
Archaeopteryx

Velociraptor

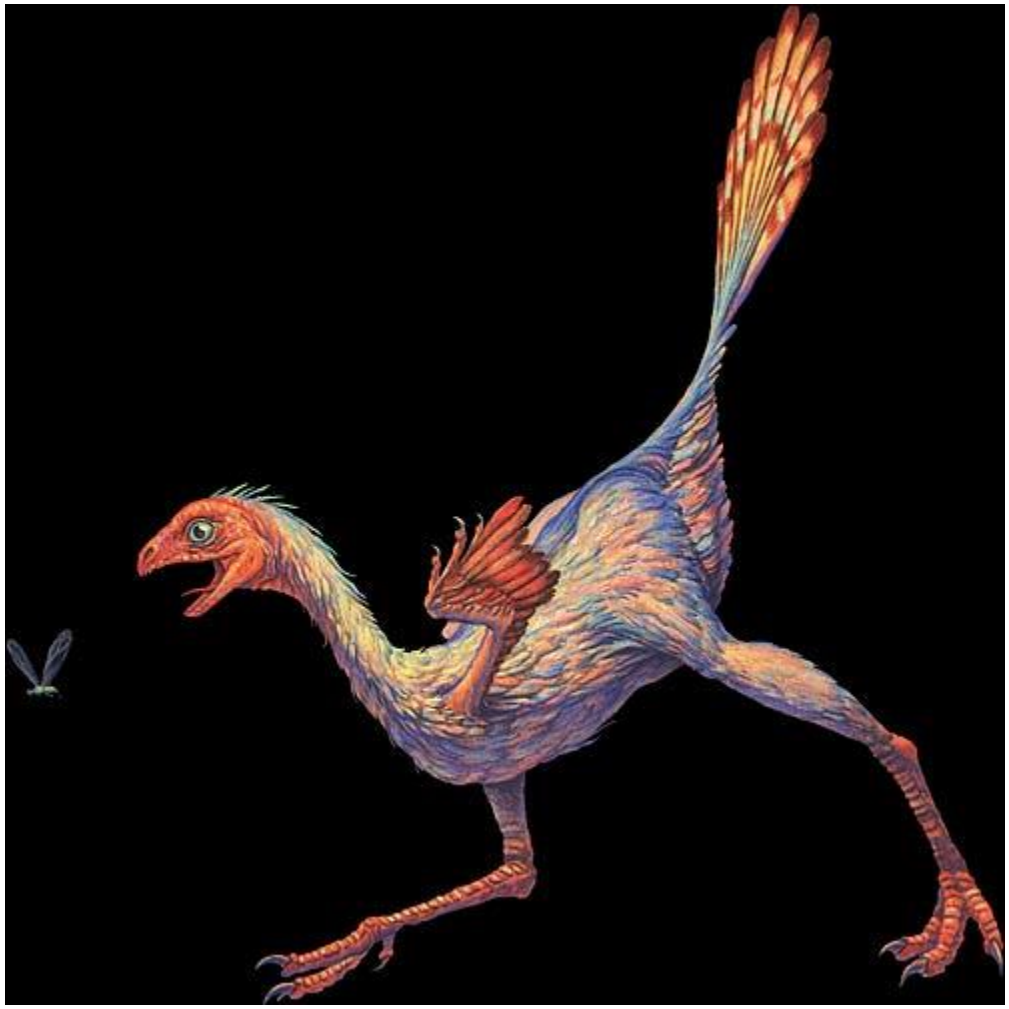
Bird origin

- Bird like features in some dinosaurs, such as feathers and primitive feathers in 120my *Sinosauropteryx prima*, and *Caudipteryx zoui*, a dinosaur with a feathered tail.
- The clade of the dinosaurs with the birds with the new discoveries has become unclear and it is difficult to say when the first bird appeared..
- Probably birds first appeared near the end of the Jurassic.
- Several different forms of birds lived during the Cretaceous.
- The group of *Congfuciusornis, Liaoningornis* (E. Cretaceous) are considered the direct ancestors of modern birds. They present characters such as sternum with carina, bird like ribs, beak.

Sinosauropteryx



Caudipteryx



Aviales και Enantiornithes

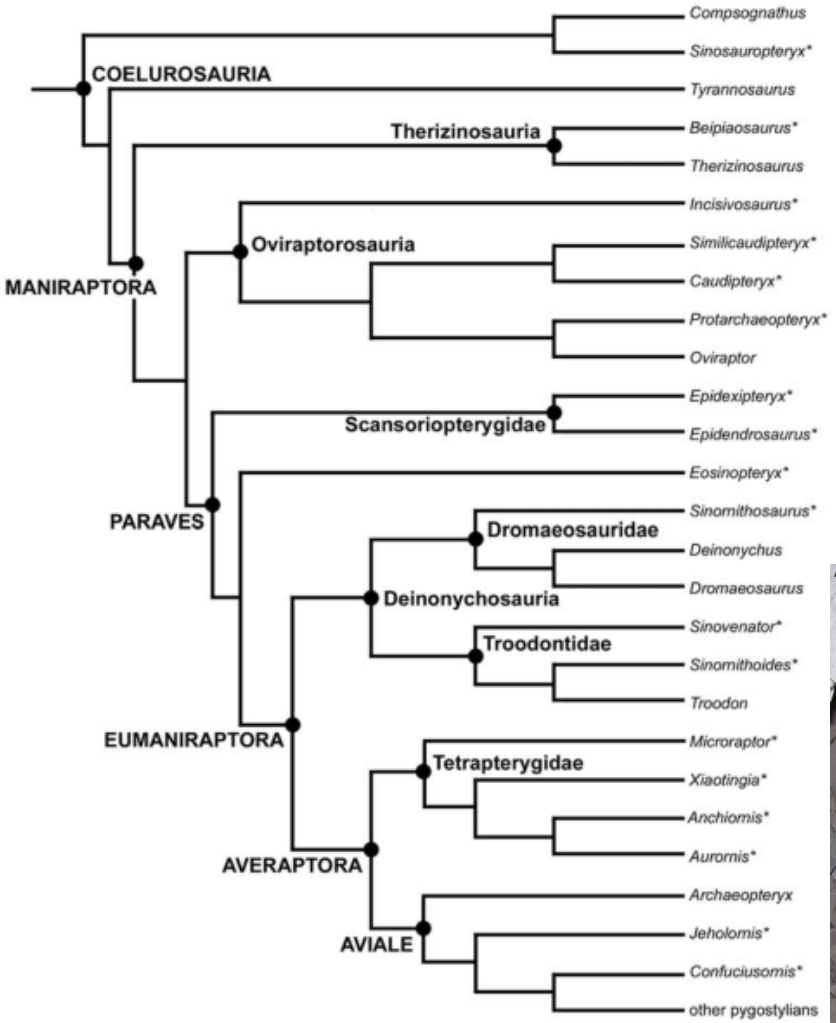
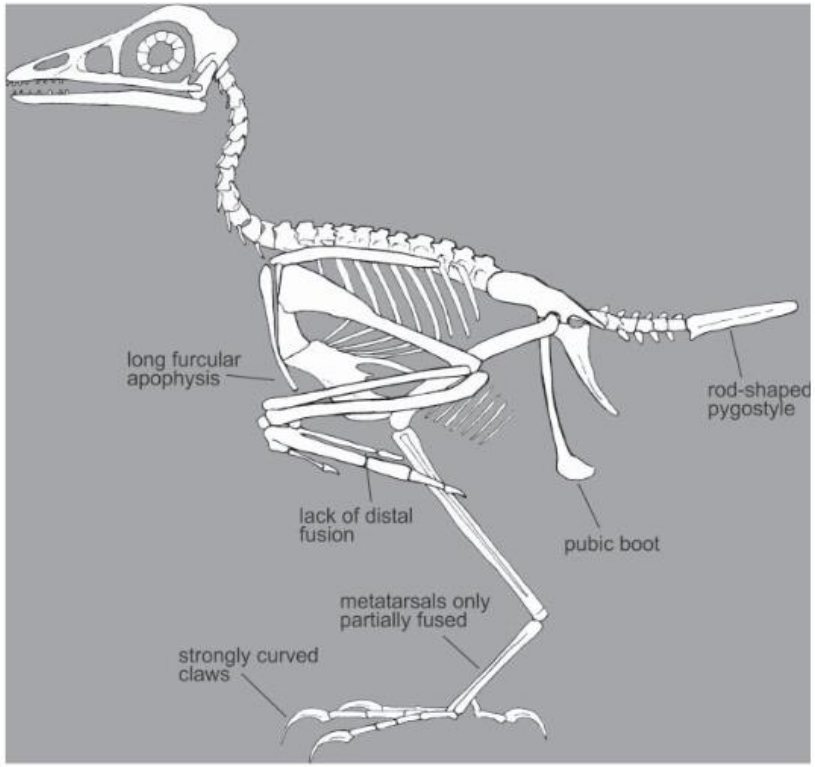
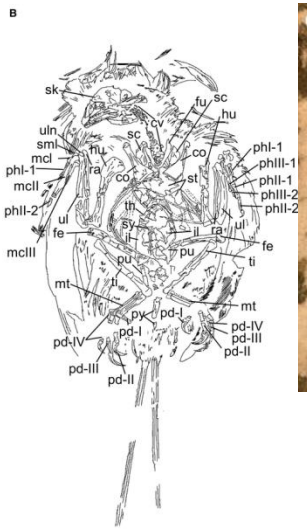
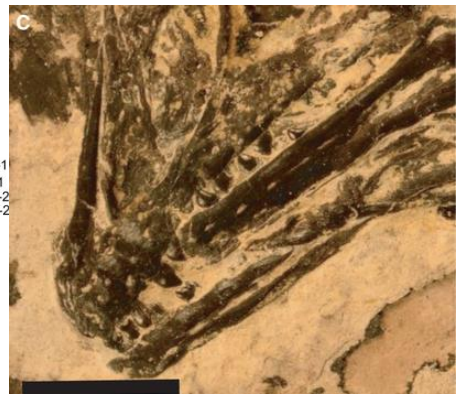


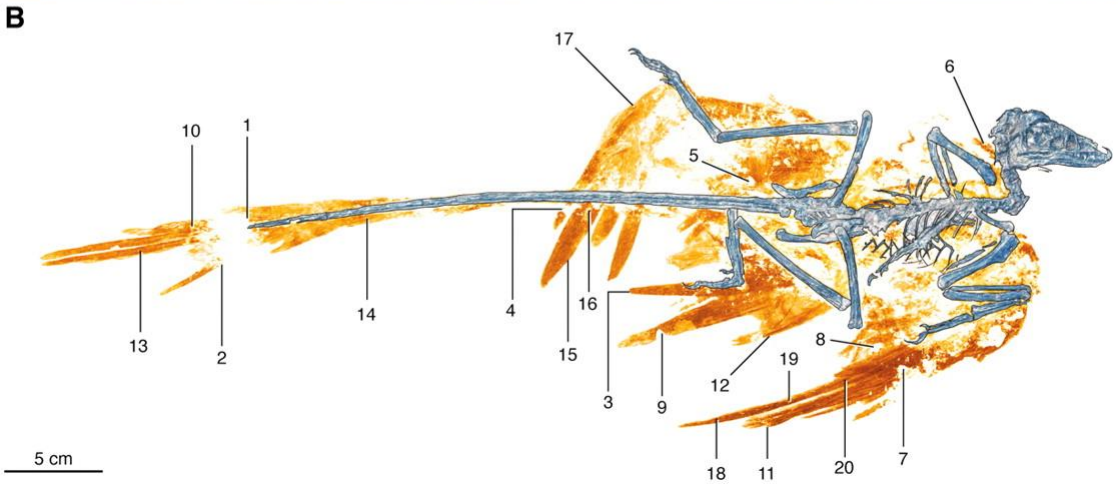
Figure 3.6 Skeleton of the enantiornithine *Sinornis* from the Early Cretaceous Jehol Biota.

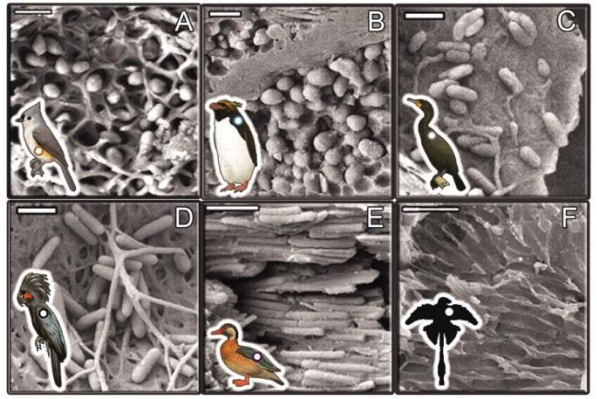


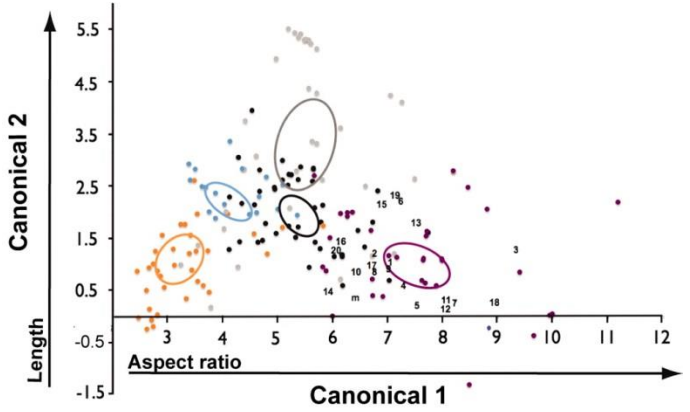




Microraptor a coloured dromeosaur!



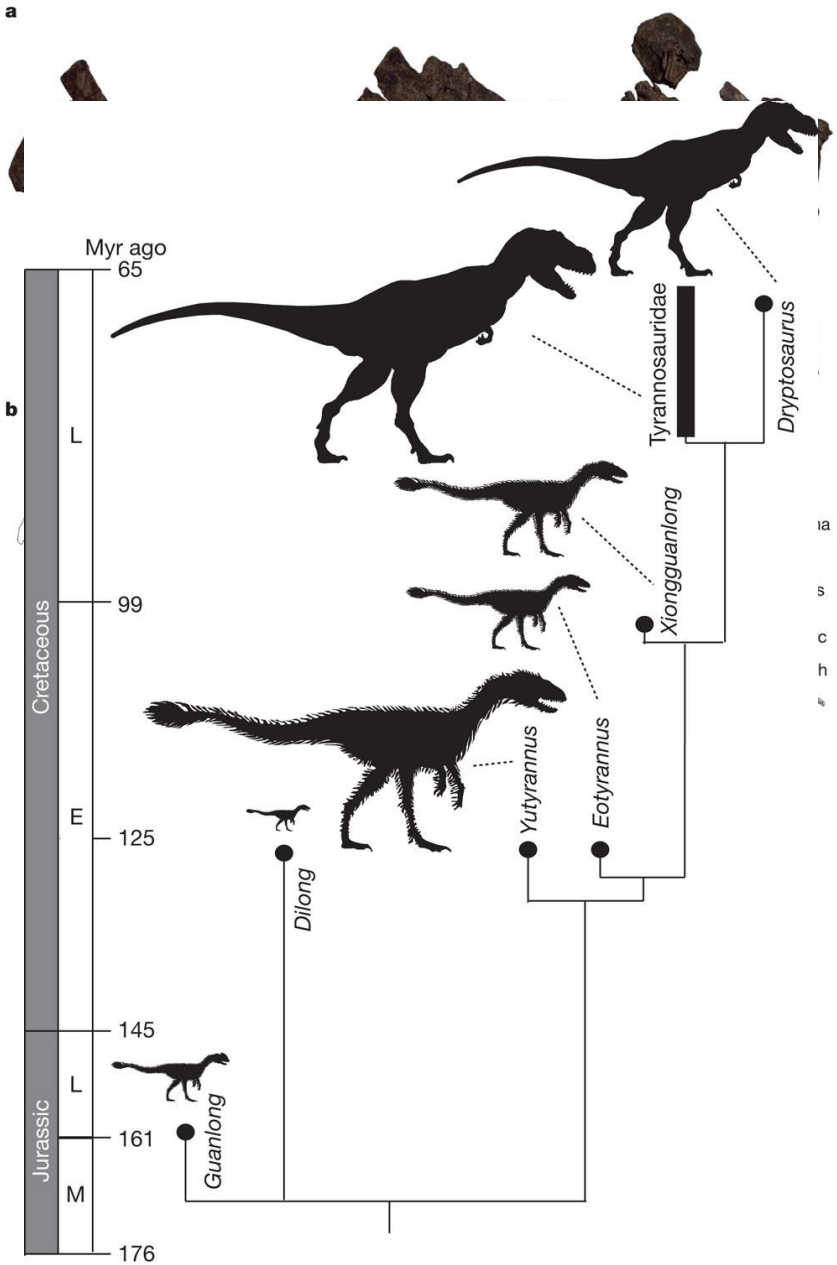


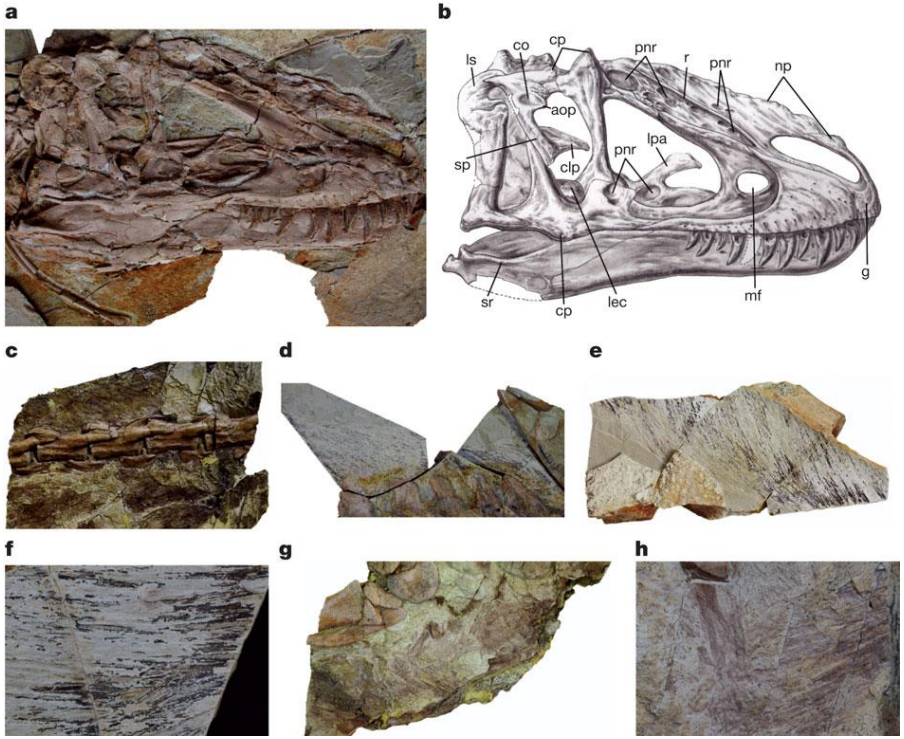


Microraptor a *dromeosaur*

We believe that birds came from a group related with the dromeosaurs, relatives of *Deinonychus* and*Velociraptor.*
Something that would look like *Microraptor* (Tetrapterigidae)

Yutyrannus huali (ZCDM V5000 and ZCDM V5001).





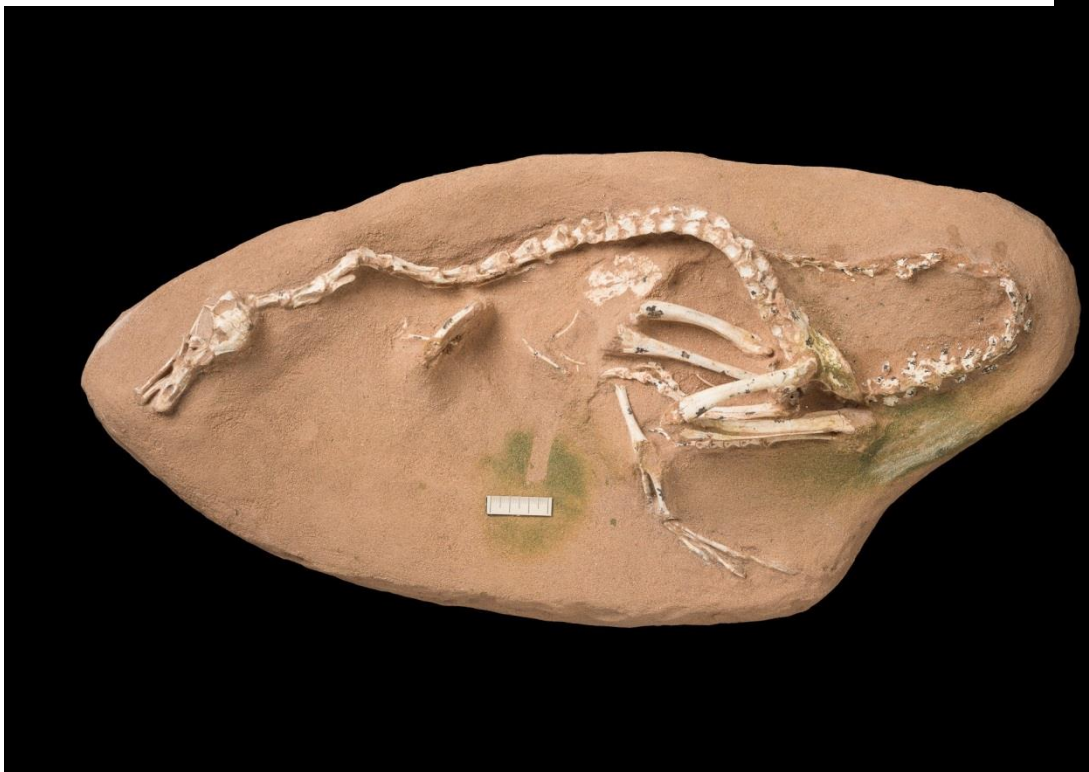
It belongs to Tyrannosauroidea!

X Xu *et al*. *Nature* **484**, 92-95 (2012)

nature

Halszkaraptor escuilliei

- Semiaquatic small dromeosaur from the L. Cretaceous of Mongolia, with finlike front limbs that enabled him to swim.



Enantiornithes and Neornithes

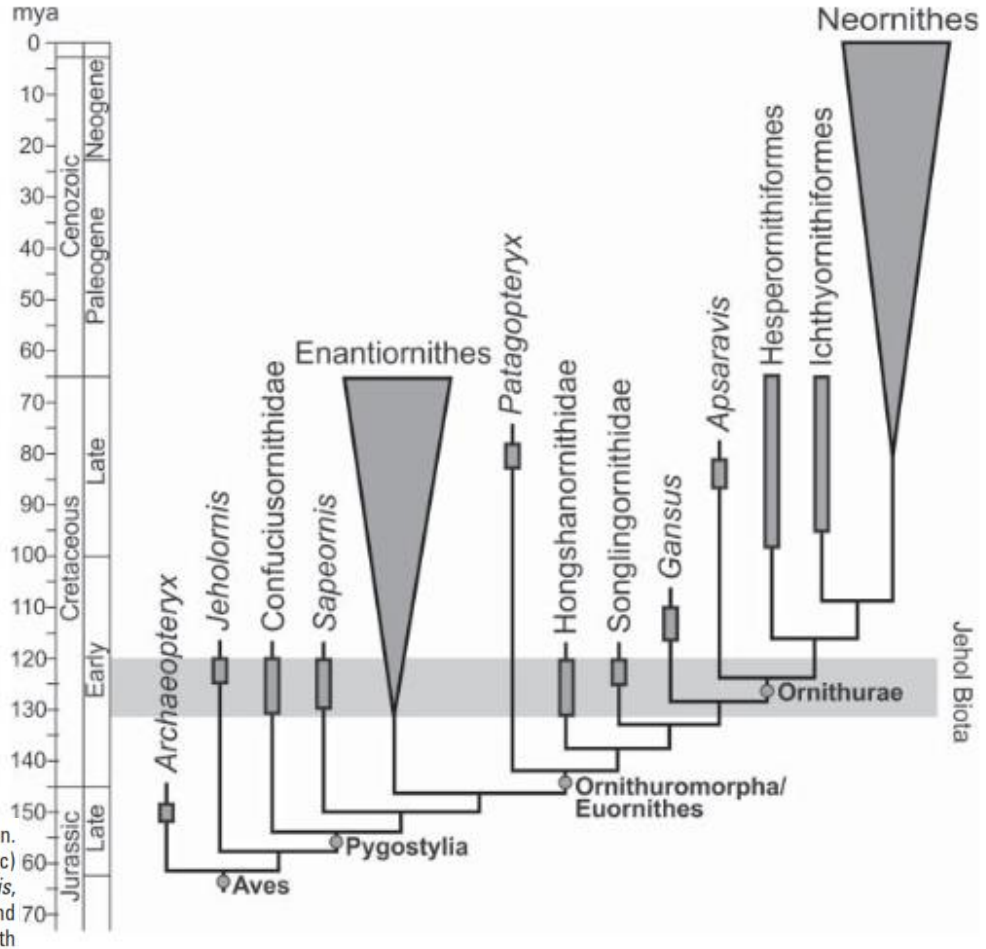
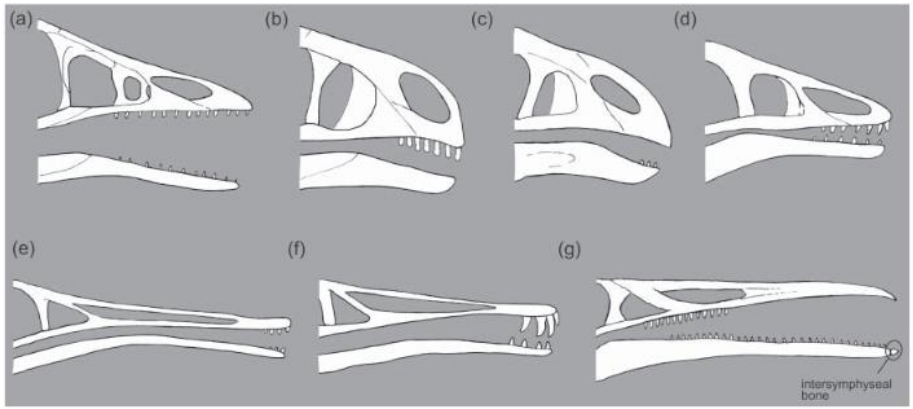
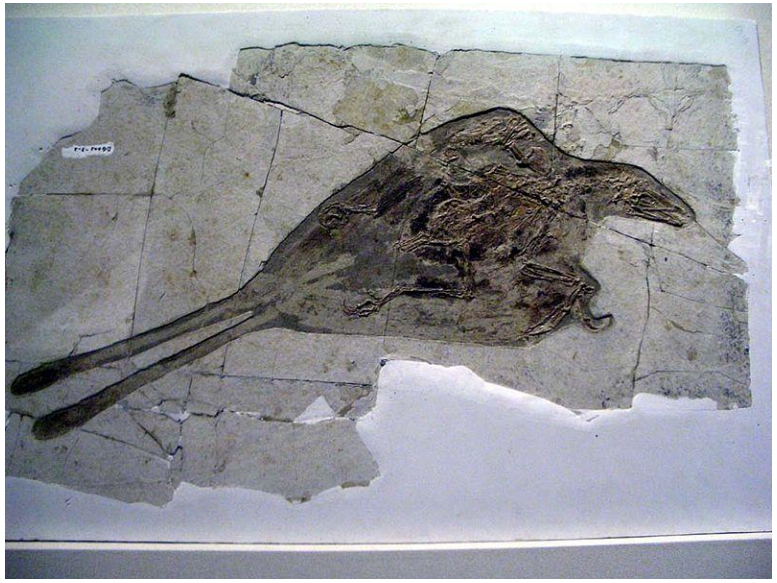


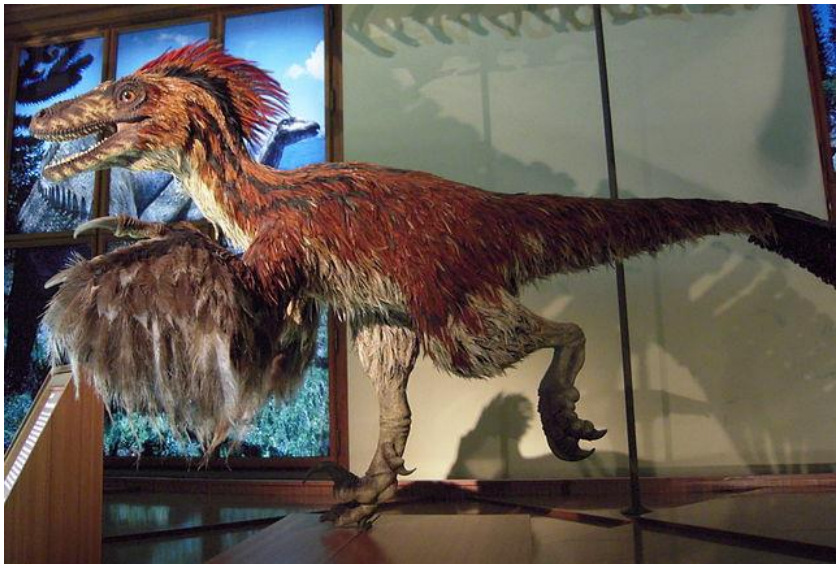
Figure 4.5 Different patterns of tooth reduction in Mesozoic birds. (a) *Archaeopteryx* with a full dentition. (b) *Sapeornis*, in which teeth are restricted to the praemaxillae and the rostral portions of the maxillae. (c) *Jeholornis*, where teeth are only present at the tips of the lower jaws. (d) The enantiornithine *Bohaiornis*, which has teeth in the maxillary, praemaxillary, and dentary bones. In the enantiornithines (e) *Rapaxavis* and (f) *Longipteryx*, the dentition is restricted to the tip of the snout. In (g) *Hesperornis*, the praemaxillae lack teeth and an intersymphyseal bone is situated on the tips of the lower jaws. Not to scale.



Confuciusornis & Deinonychus

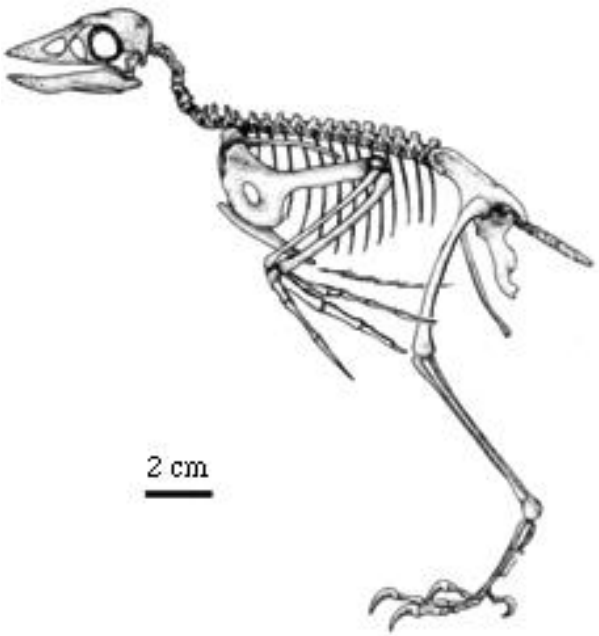


Confuciusornis sanctus

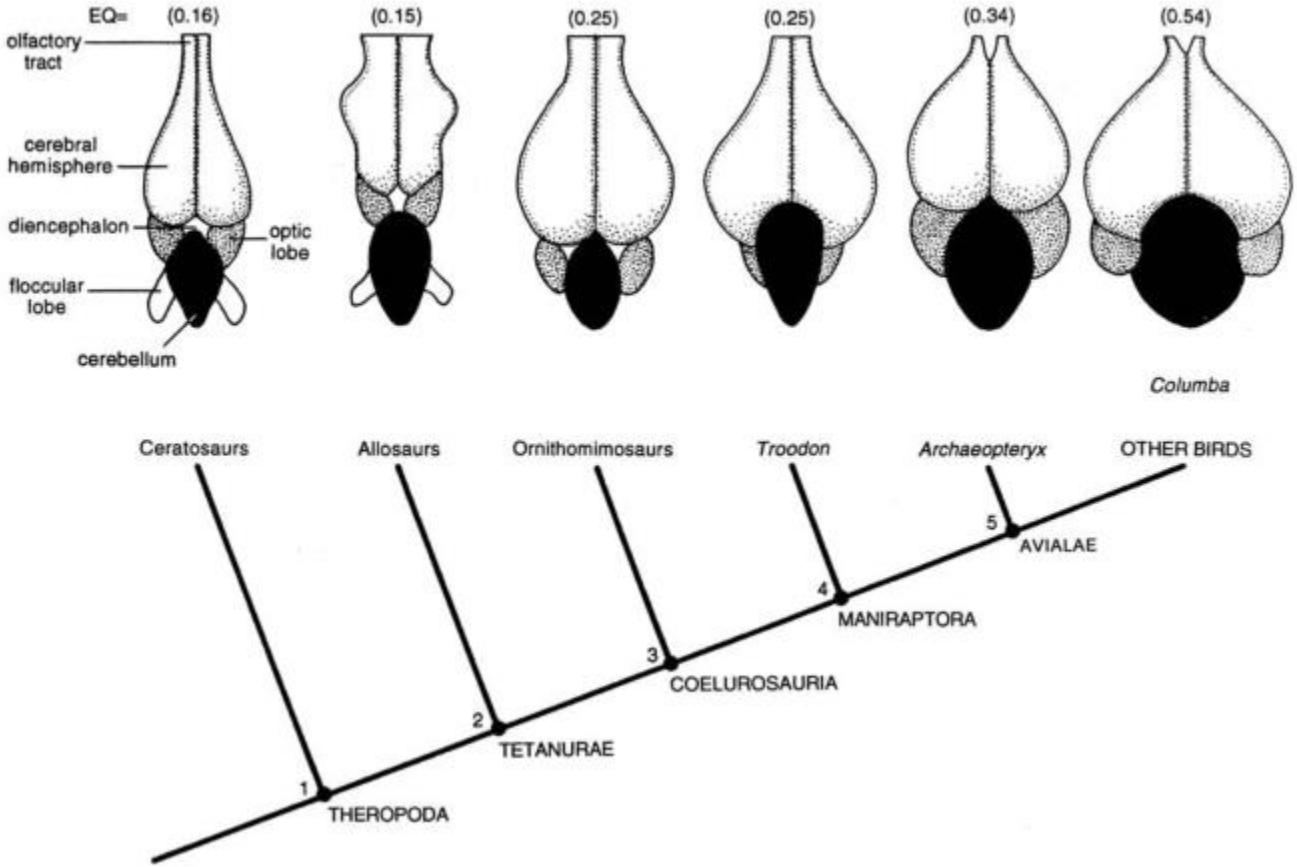


Feathered Deinonychus, Life History Museum ,Vienna

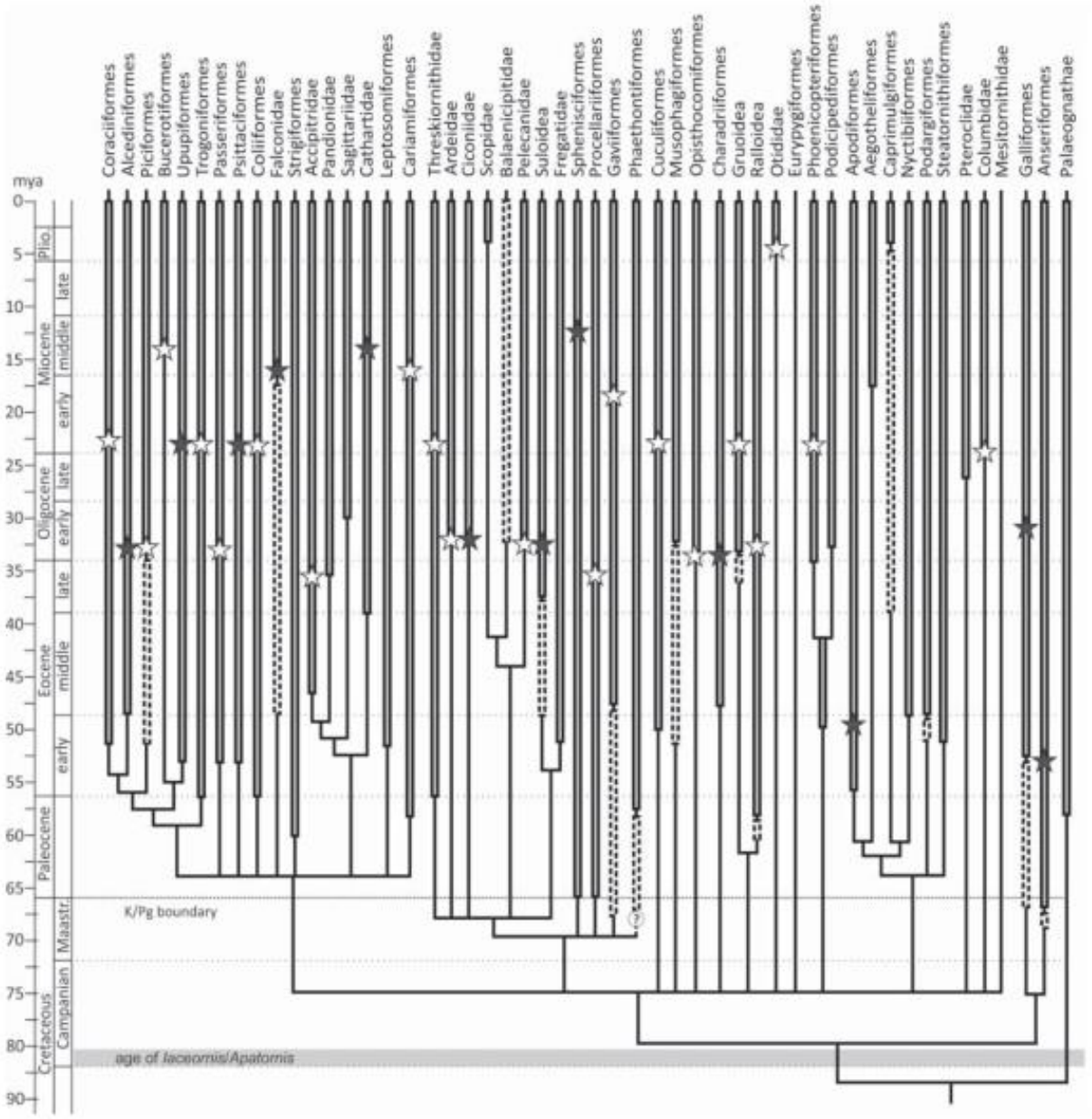
Confuciusornis




Feathered Dinosaurs



- Gradual enlargement of the brain in theropods, originally in the arboreal Coelurosauria which continued in Avialae and birds
- Adjustment to locomotion in three dimensions in the tree habitat
- In Avialae and birds the cerebral cortex gradually increases for balance and coordination, the optic lobes increase for optic acuteness and the olfactory bulbs on the other head are reduced showing less dependence from olfaction



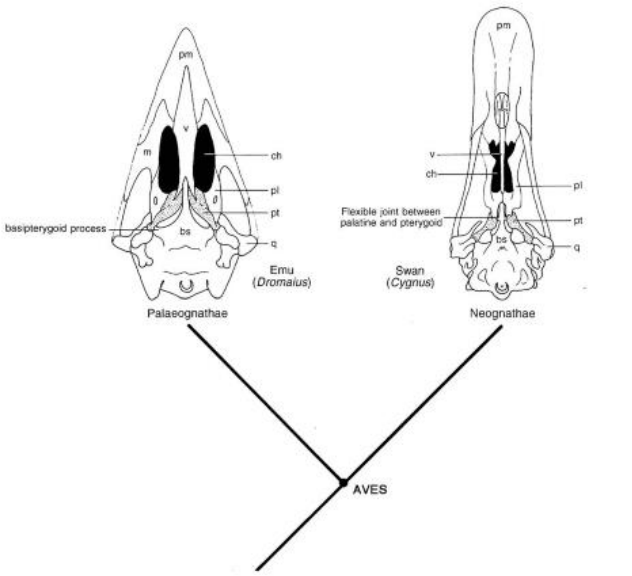


Figure 11.6. Cladogram showing the basal dichotomy of the Aves into Palaeognathae and Neognathae on the basis of palatal structure. Reduction of the vomer and basipterygoid process and development of the flexible joint between the pterygoid and the palatine are novelties for the neognaths. bs, basisphenoid; ch, choana; m, maxilla; pl, palatine; pm, premaxilla; pt, pterygoid; q, quadrate; v, vomer (after Chatterjee 1997)

Palaeognatha differ from Neognatha in the form of their palatal bones in the skull. They were separated 85 my

Aves

- Bird fossils are rarely preserved, thus the Cenozoic fossil archive is poor.
- During the Cenozoic significant adaptive radiation.
- Fossils are more easily preserved in the large flightless birds that some times are taller than 2 m. Some of them are, *Diatryma (*Eocene*), Aepyornis* (Pleistocene),

Andalgalornis

Diatryma

Late Eocene, Messel

Therapsida

- Mammals are synapsids, a group including the pelycosaurs from the Late Paleozoic.
- The therapsids probably evolved from the pelycosaurs.
- Mammals evolved from the therapsids that survived the Permian extinction event.
- The therapsids were small to medium-sized vertebrates, sharing several common characters with mammals such as:
  - Differentiated teeth
  - Legs under the body.

Cynodontia

- A group of therapsids that became very common in the Triassic.
- Cynodontia had several mammalian characters, such as the bony palate, which allowed breathing along with chewing, a very important development on the way towards mammals.


Procynosuchus


BBC

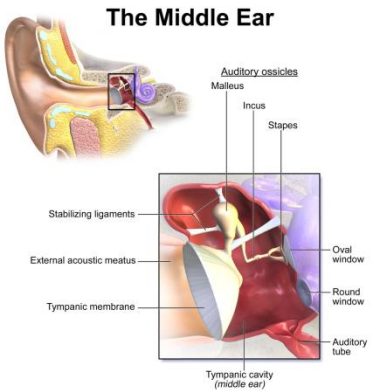
The appearance of mammals

- In Early Jurassic the therapsids became extinct after they gave rise to the mammals.
- The mammals first appeared in the Late Triassic (220-225 my), the first ones were *Adelobasileus* and *Sinoconodon*.
- The first were rodent like animals, and remained small throughout the Mesozoic.

Mammals

- The most primitive mammals are called Prototheria (fossilized forms and monotremata)
- Most of the rest belong to Theria, divided into:
  1. Metatheria (marsupials)
  2. Eutheria (placentals)
- Living mammals are divided into three groups:
  Monotremata - primitive that lay eggs.
  Marsupialia - they transport their babies in a pouch.
  Placentalia - Pregnancy lasts longer and they give birth to developed babies

Mammals



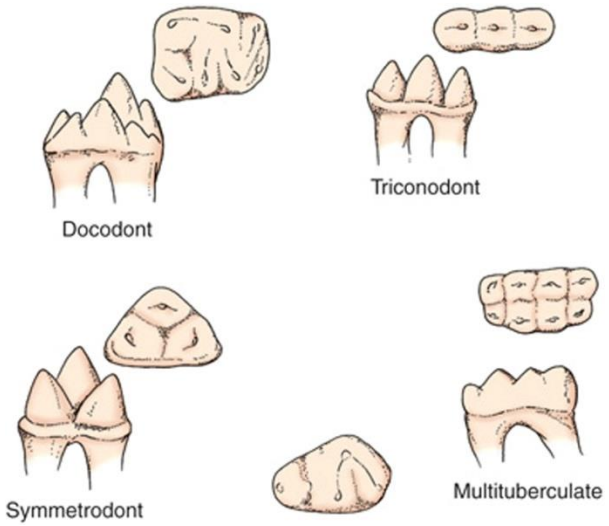
- They are endotherm animals, differentiated because:
  - They have hair or fur
  - The females have milk glands that secrete milk to feed their babies.
- They have three ossicles in the middle ear malleus, incus, and stapes (hammer, anvil, stirrup) instead of one that the reptiles have (stapes). This provides them with better hearing.
- Articulation of the jaw in the skull, and its function as one bone.
- The first to show these characters are Morganucodon, Megazostrodon, Eozostrodon.

Mammal teeth

- Their typical feature is the differentiated teeth: incisors, canines, premolars and molars.
- Mammals have deciduous (milk) teeth that are then lost, proof is that they are breastfeeding, and are replaced by permanent (thus, only 2 sets of teeth, unlike the constant replacement in reptiles).
- Mesozoic mammals can be identified and classified based on the morphology of their teeth.

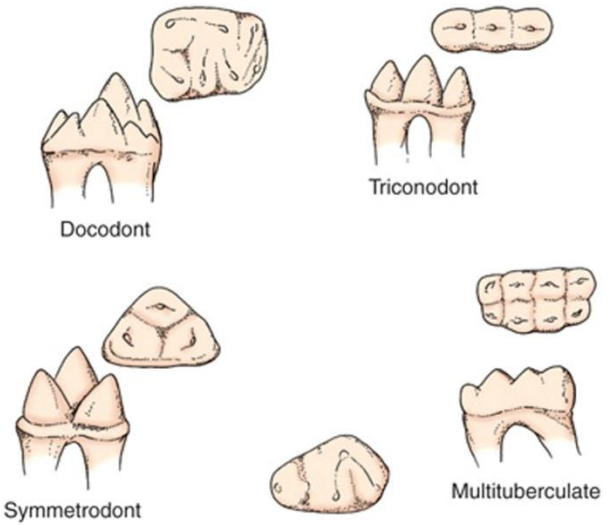
Mammal teeth

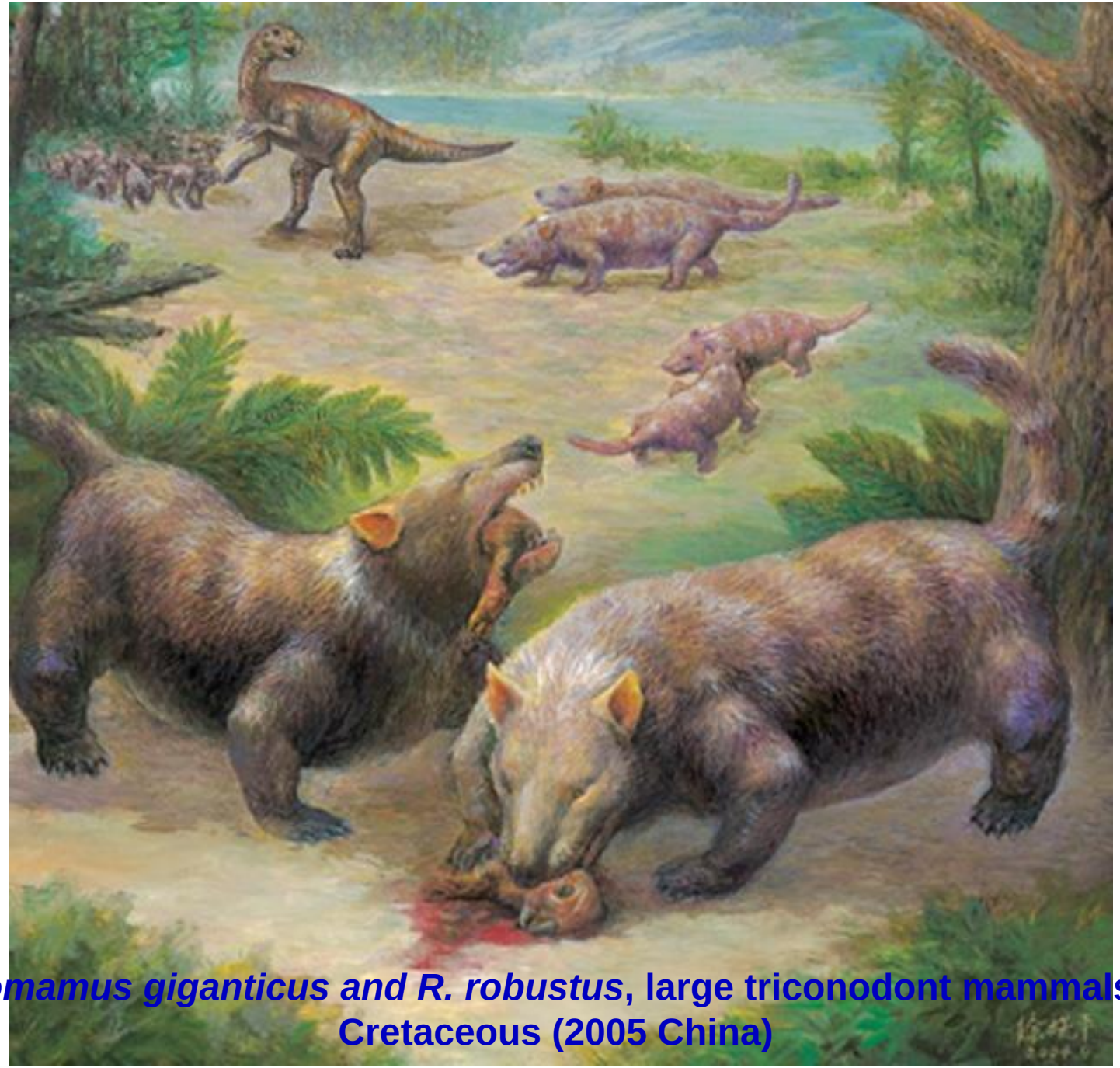
1. Triconodonta - with molars with three cusps in a row. Cat sized. Probably carnivorous.
2. Morganucodonta - similar teeth with Triconodonta, lower jaw and skull hold traits of reptiles. Skeleton like the therapsids.
3. Docodonta - with sophisticateds multi cusp molars, possibly ancestors of monotremata, insectivorous.
4. Symmetrodonta - molars with a tri-cusp tooth type. Possible ancestors of placentals and marsupials.



Mammal teeth

5. Multituberculates – molars with several cusps. Perhaps the first herbivorous mammals. Rodent like forms. They appeared at the end of the Jurassic and survived for 100 my.
6. Eupantotheria - had 7 or 8 molars. Also possible ancestors of placentals and marsupials.
7. Theria - "the real mammals". They appeared in the Early Cretaceous.

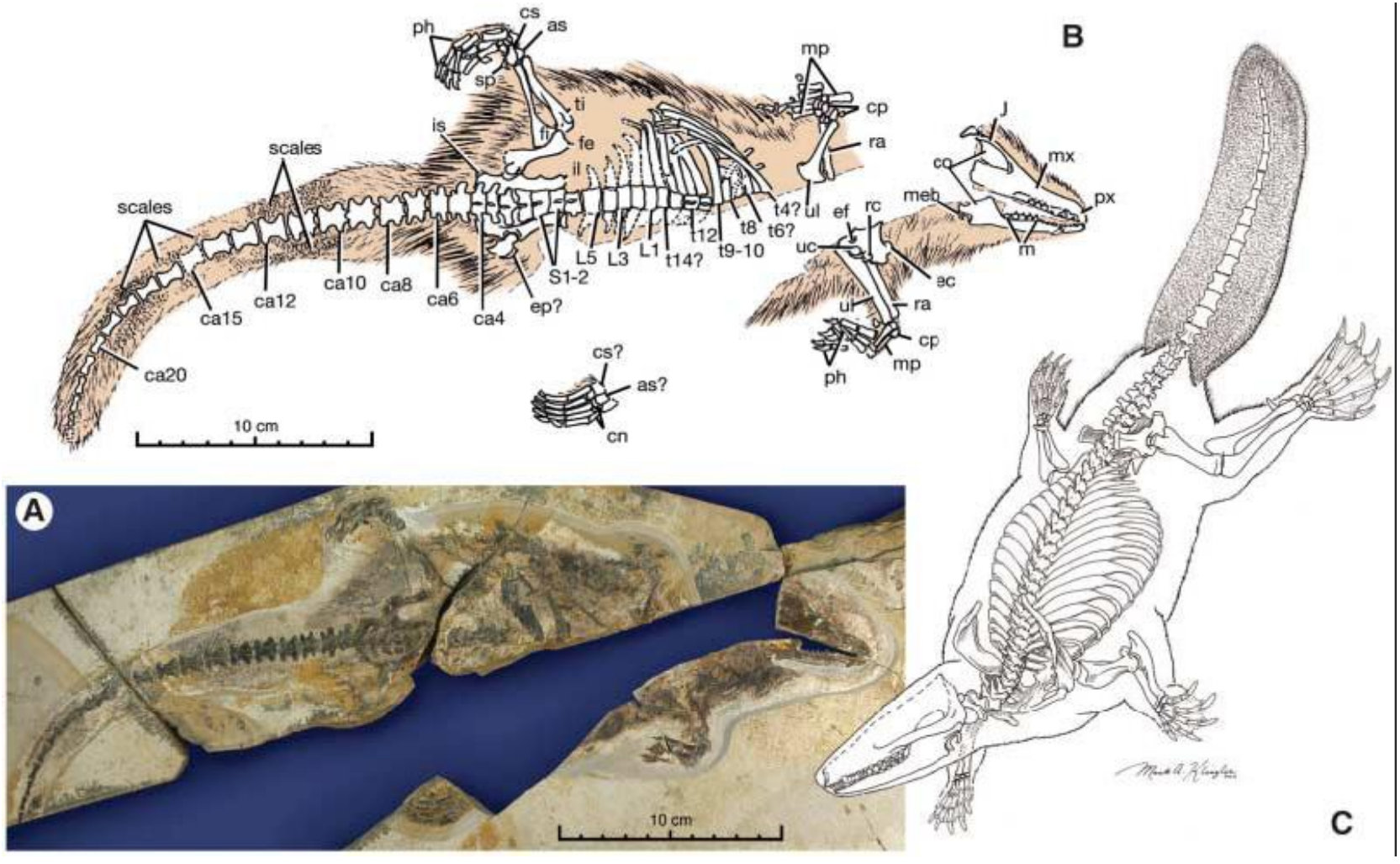




***Repenomamus giganticus and R. robustus*, large triconodont mammals of the Cretaceous (2005 China)**

Castorocauda lutrasimilis

In 2006, a docodont was discovered from the Middle Jurassic of China, one which was able to swim and to dig. The first aquatic mammal.



Eomaia scansoria

- The first placental mammal
- Lower Cretaceous of China

Marsupials

- In Australia and South America
- In Australia the only mammals until the Pleistocene
- They covered all the ecological niches, herbivores and carnivores

***Thylacosmilus atrox*, Pliocene**

Insectivora

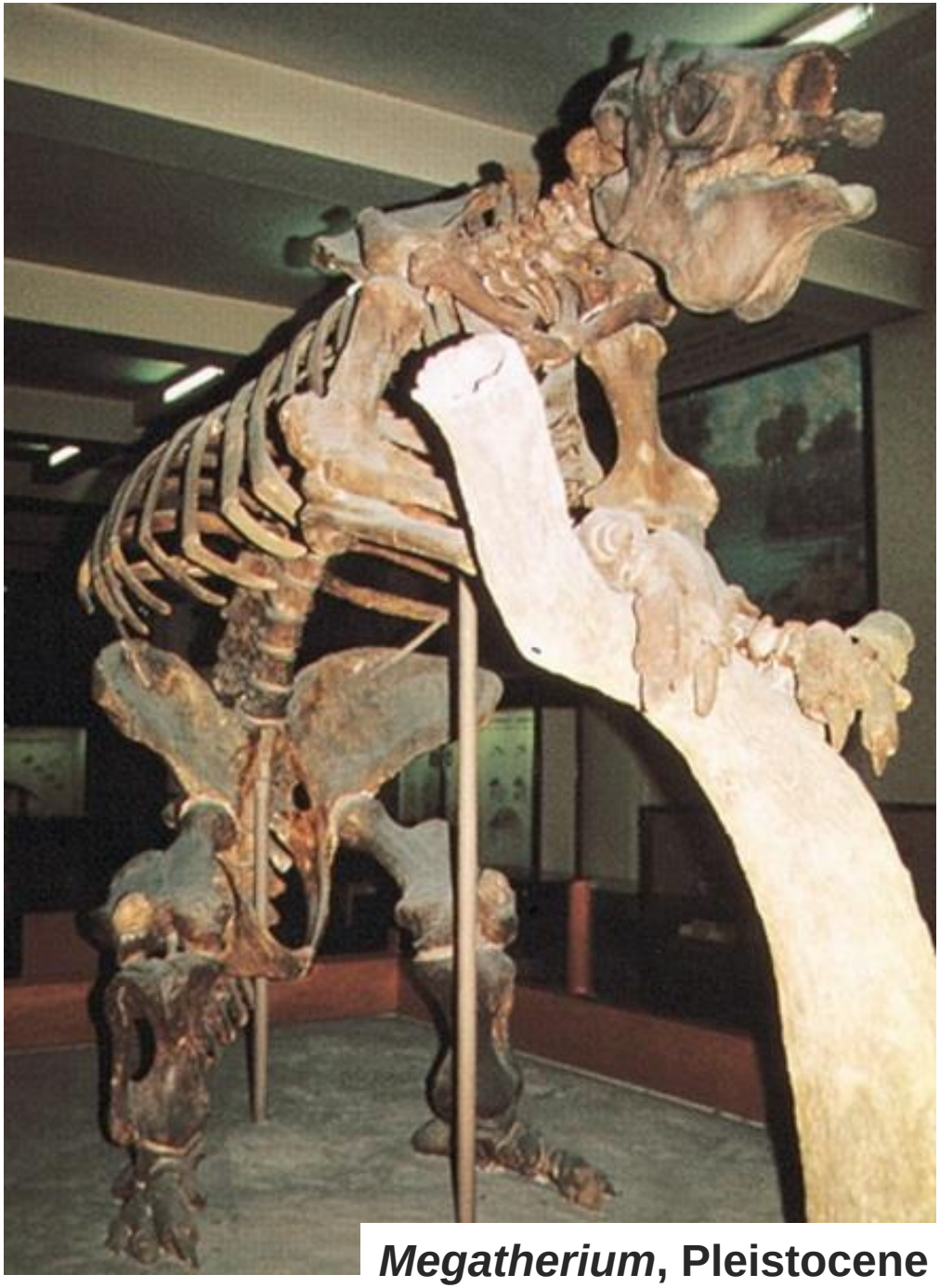
- Most of the placental orders came from these mammal order:
- Endentata
- Chiroptera
- Primates
- Rodentia
- Carnivora

Endentata

- Animals such as Armadillo, sloths and anteaters.
- Fossilized forms are the glyptodonts, and the giant ground sloths.

Armadillo

Glyptodont

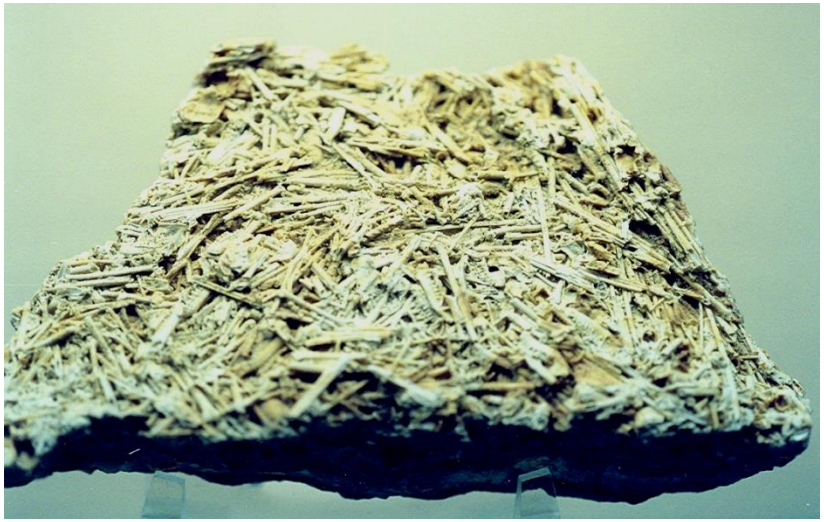


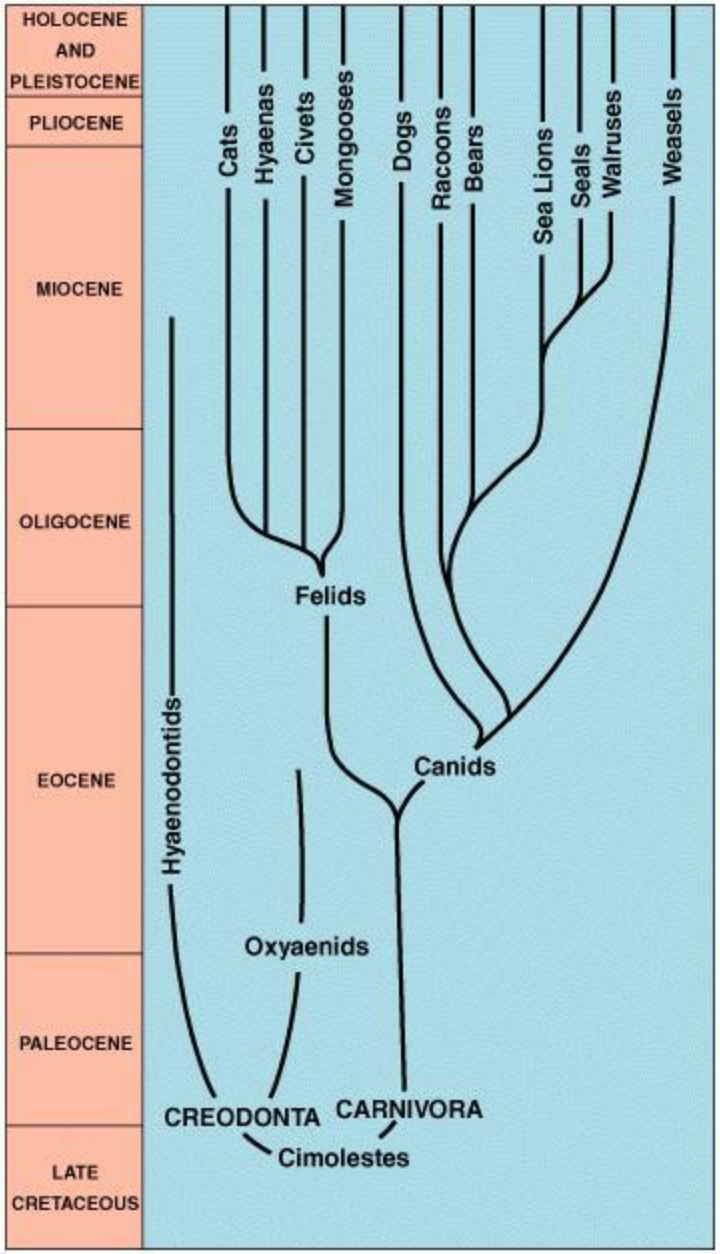
***Megatherium*, Pleistocene**

Chiroptera

- Flying mammals that evolved in the Cenozoic
- Bat teeth in Paleocene layers
- The first complete fossils in the Eocene
- The wings developed on elongated phalanges.

Bat bones

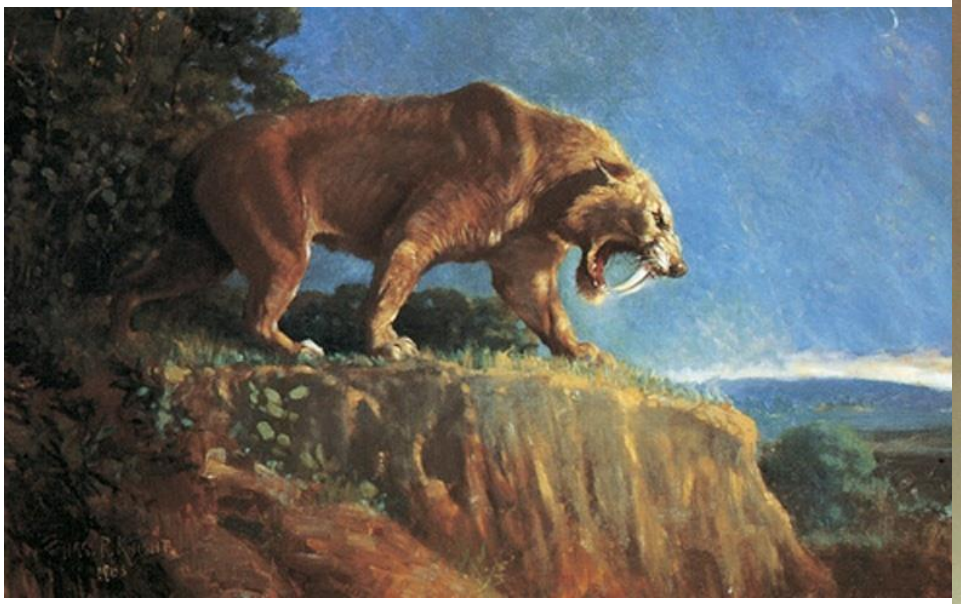


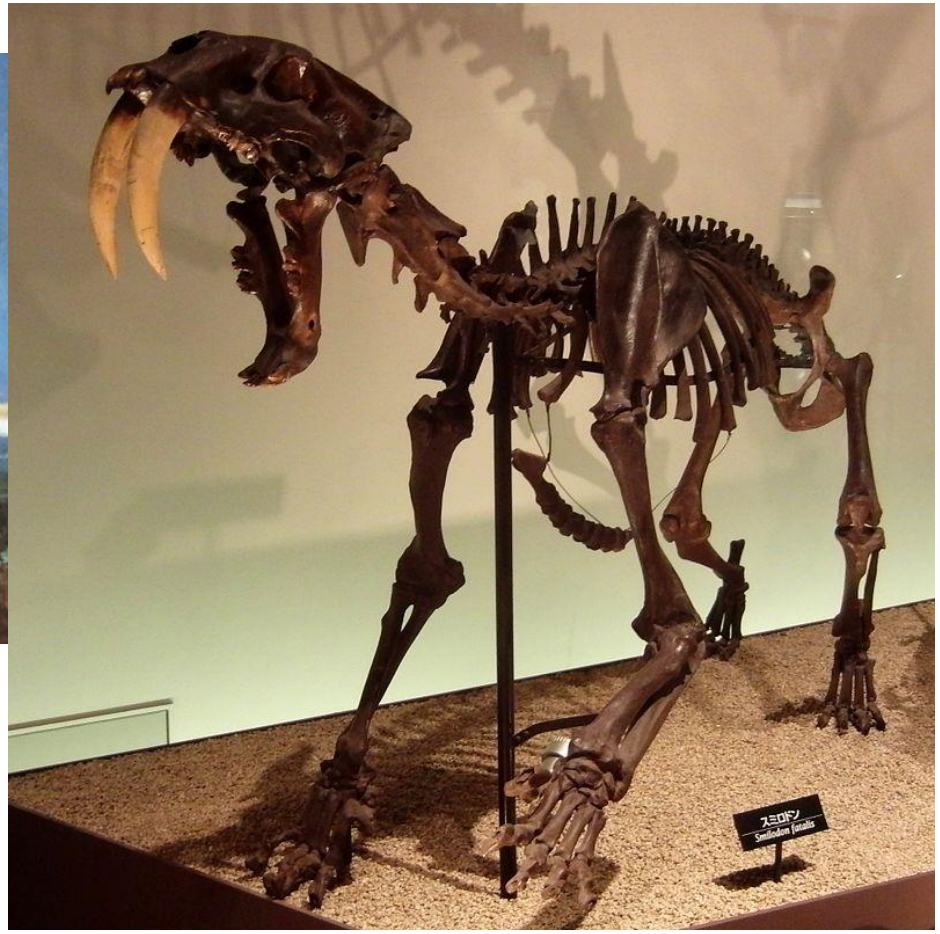

HOLOCENE AND PLEISTOCENE
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
LATE CRETACEOUS
Cats
Hyaenas
Civets
Mongooses
Dogs
Racoons
Bears
Sea Lions
Seals
Walruses
Weasels
Felids
Canids
Hyaenodontids
Oxyaenids
CREODONTA
CARNIVORA
Cimolestes

Carnivora

Carnivora

- The first placental carnivores in the Cretaceous.
- Creodonta - Carnivorous animals with small brains, short legs and nails. The dominant carnivores of the Palaeocene. Ancestors of carnivores.
- Carnivora - Felidae, Hyaenas, Canidae, raccoons, bears, mustelidae
- Pinnipedia, seals, sea lions, sea elephants.





Saber tooth cat *Smilodon fatalis* skeleton, National Museum of Nature and Science, Tokyo

Carnivora

- The first true carnivores in the Upper Palaeocene and Lower Eocene.
- The miacid Vulpavus is the first, with a long skull that probably hunted small mammals.
- Modern groups began to differentiate during the late Eocene – early Oligocene.
- The felines contain cats, extinct Nimravidae, hyaenas, civets, mongooses. Mongooses (Herpestidae) appeared in L. Oligocene, and the civets (Viverridae) in L. Eocene. From Viverridae the hyaenas (Hyaenidae) evolved in the Miocene, and the felines (Felidae) in E. Oligocene.
- The second group, the cynomorphs, includes dogs (Canidae), and arctoids (bears, raccoons, ferrets and seals).
- Weasels (Mustelidae) and raccoons (Procyonidae) appear respectively in E. Miocene and L. Oligocene. Amphicyonidae - extinct cynomorphs of North America (L. Eocene – L. Miocene). The bears (Ursidae) appeared in the L. Eocene.

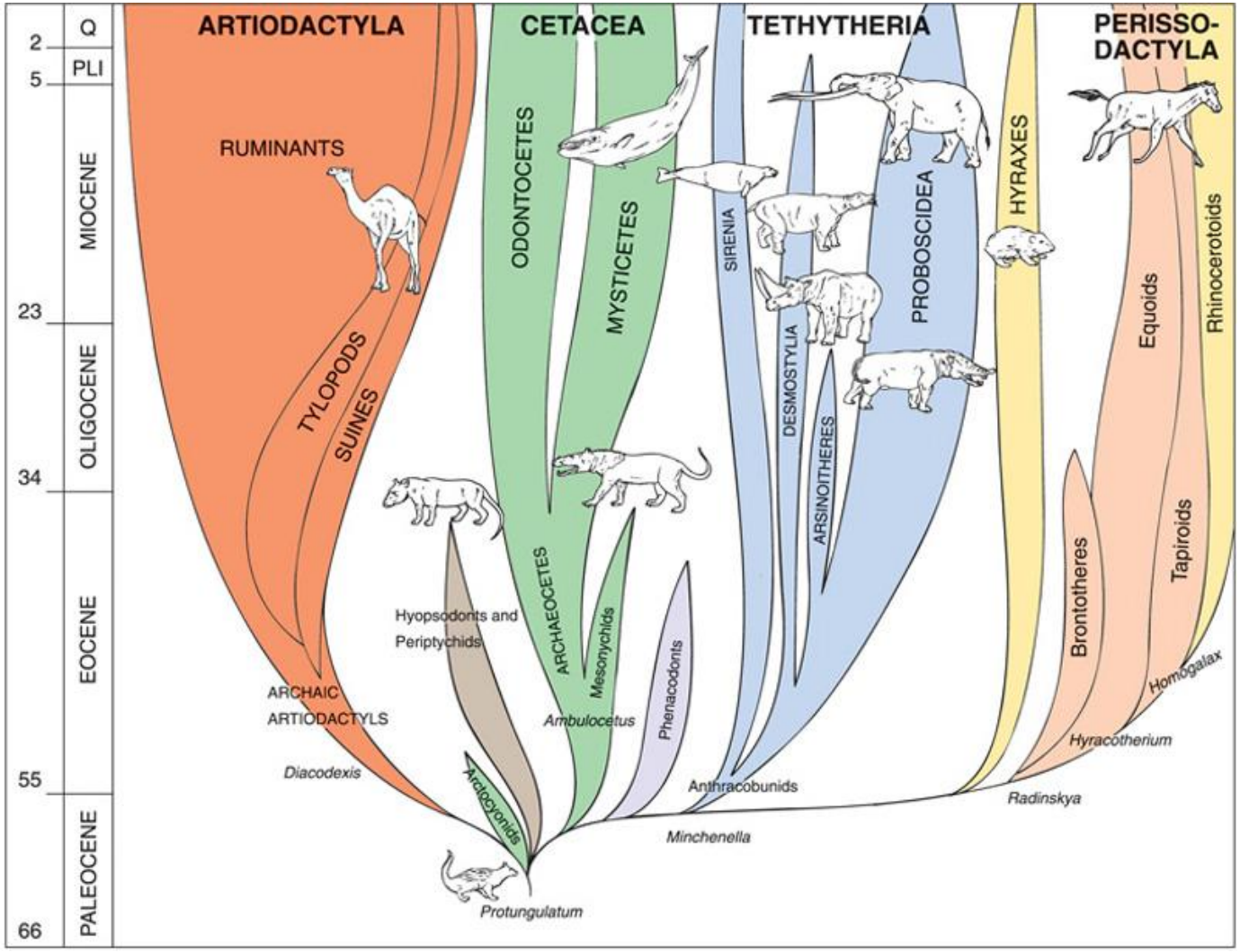
Pinnipedia

- Pinnipedia are associated with the arctoids
- The first appeared in the L. Oligocene to M. Miocene (Enaliarctos)
- Three modern families, Otariidae (sea lions), Odobenidae (sea elephants), Phocidae (seals)

Ungulata

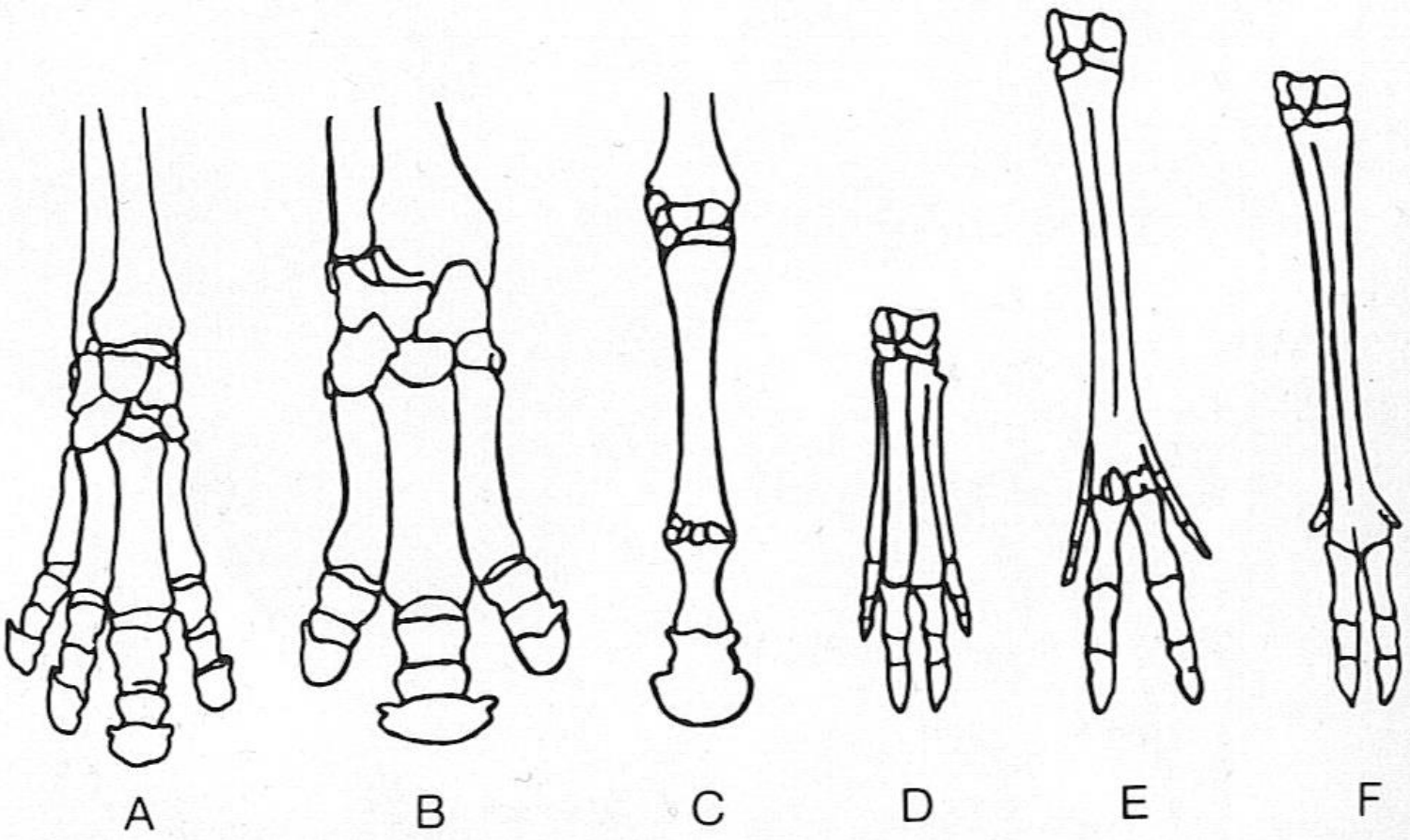
- Horses, bovids, deer, camels, rhinos, etc.
- It includes descendants of ungulates such as cetaceans, sirenians, proboscideans.

Ungulata

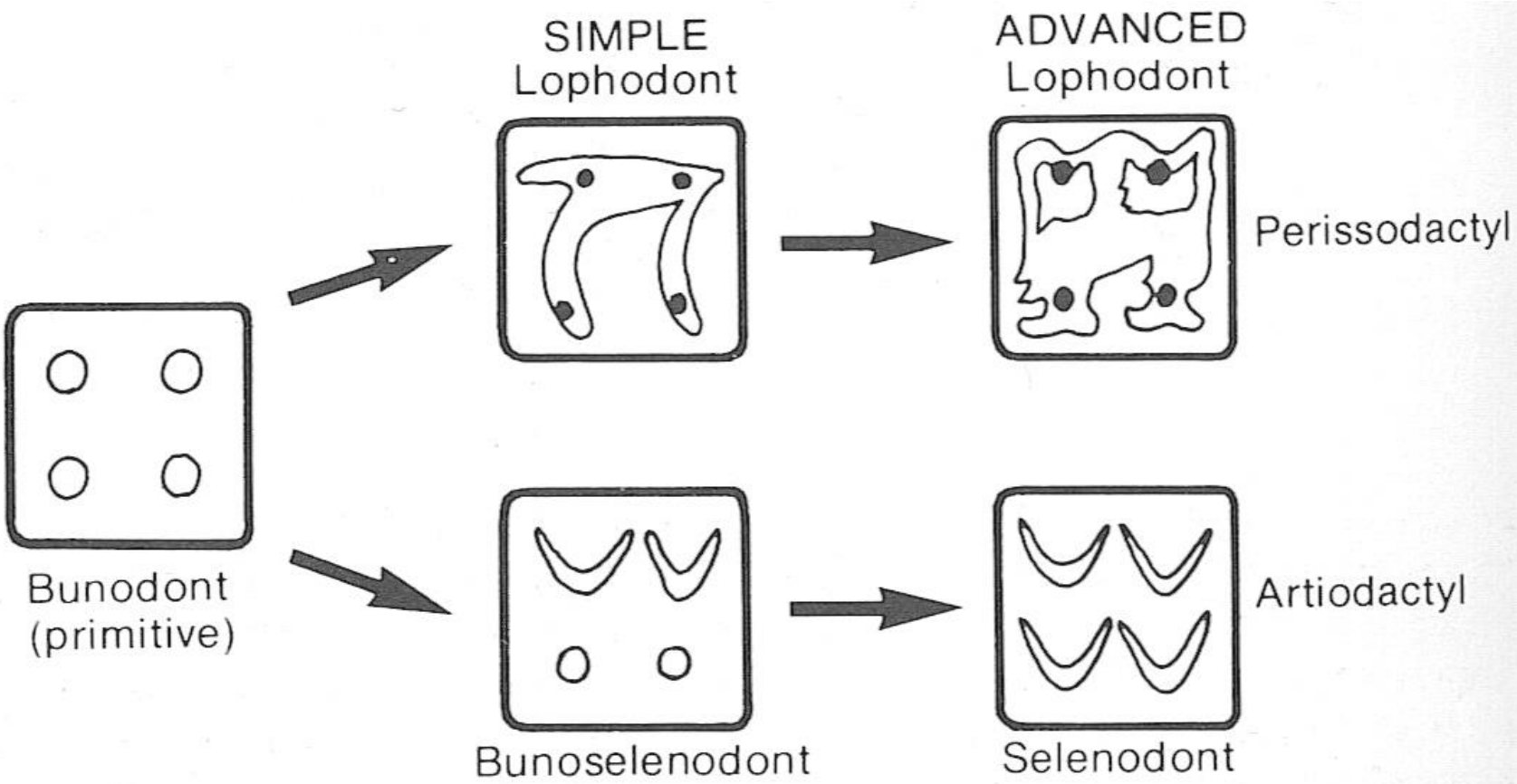

Q
PLI
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
2
5
23
34
55
66
ARTIODACTYLA
CETACEA
TETHYTHERIA
PERISSO-
DACTYLA
RUMINANTS
TYLOPODS
SUINES
ODONTOCETES
MYSTICETES
SIRENIA
DESMOSTYLIA
ARSINOITHERES
PROBOSCIDEA
HYRAXES
Equoids
Rhinocerotoids
Brontotheres
Tapiroids
Homogalax
Hyracotherium
Radinskya
Hyopsodonts and
Periptychids
ARCHAIC
ARTIODACTYLS
Diacodexis
ARCHAEOCETES
Mesonychids
Ambulocetus
Phenacodonts
Anthracobunids
Minchenella
Protungulatum

Perissodactyla

- Odd number of digits (1 or 3) on each leg.
  Reduction of lateral digits.
  Horses, rhinoceroses, Tapirs, and extinct ones such as chalicotheria, brontotheria, titanotheria, etc.



Forefoot of both odd (A–C) and even (D–F) toed ungulates to show the reduction of the digits in each. A Tapir (4 toes); B Rhinoceros (3 toes); C Horse (1 toe); D *Leptomeryx* (2 toes and 2 reduced toes); E *Blastomeryx* (2 toes and 2 vestigial toes); F *Merycodus* (2 toes).

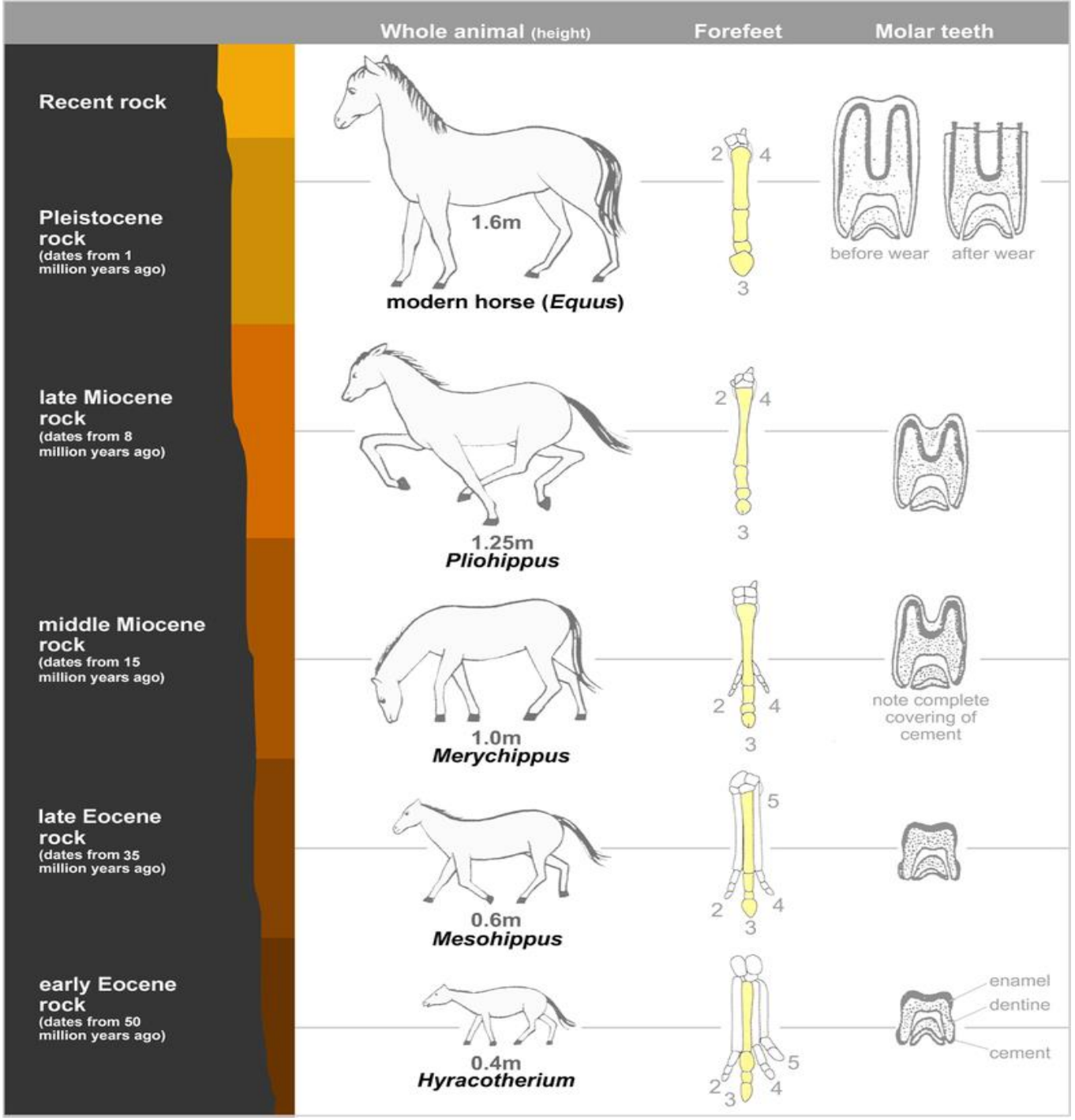


Diagrammatic sequence of evolutionary changes from a simple four cusped bunodont ancestral form of molar tooth into typical perissodactyl and artiodactyl patterns.

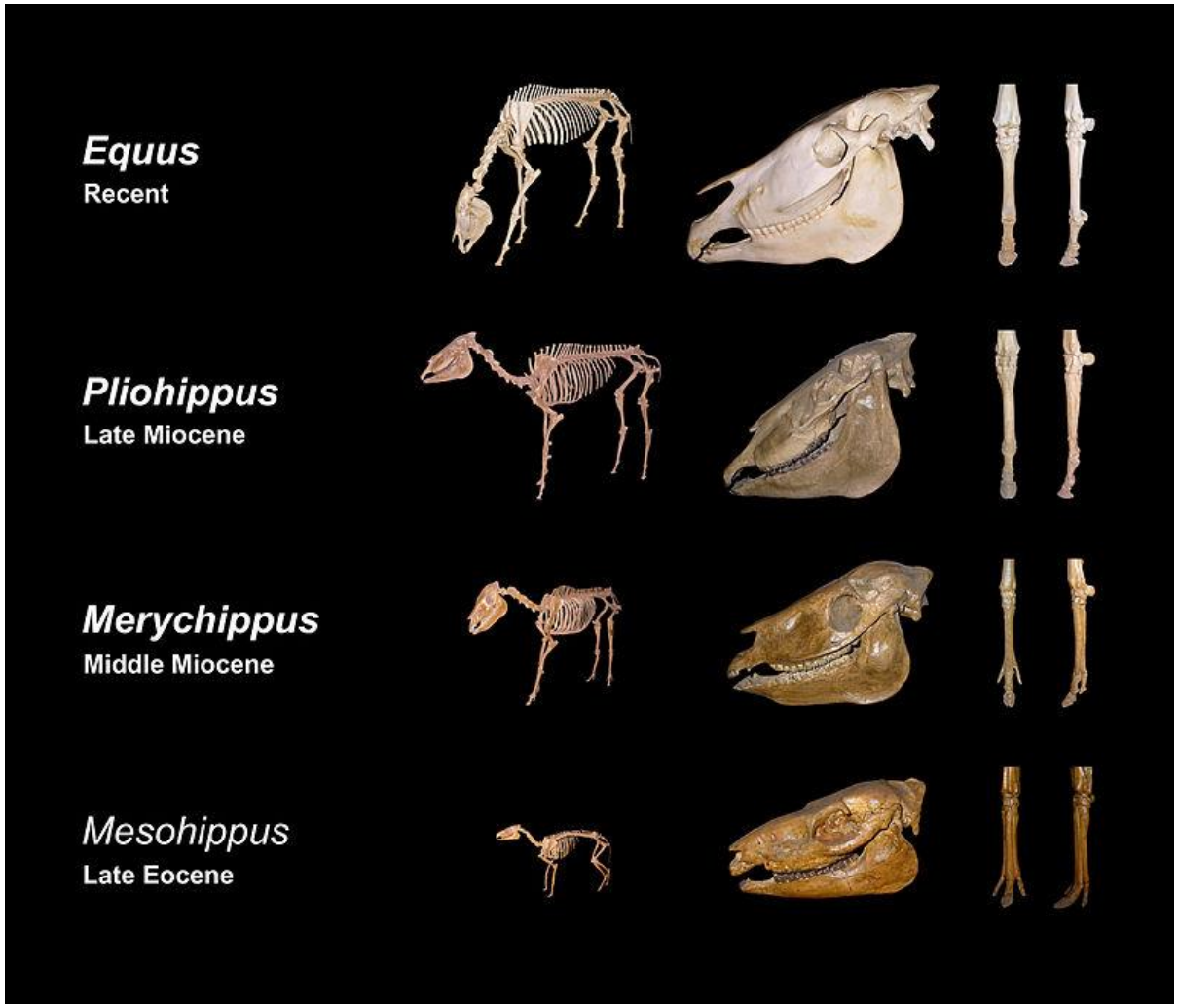
Horse evolution

- It took place in North America
- Modern horse has a single digit and has evolved from small (40 cm tall Hyracotherium) Oligocene browsers with 4 digits on the front and 3 on the hind limbs.
- From a small-sized animal with a short skull and low-crown teeth to a larger animal with fewer digits, a longer skull, a larger brain, and complex teeth with a high crown to chew grasses.

Representative sequence of the horse's evolution with depiction of the front left leg and teeth.

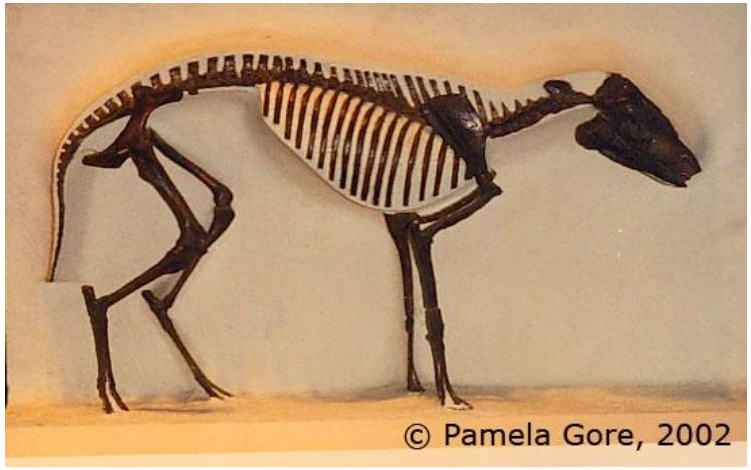


Horse evolution

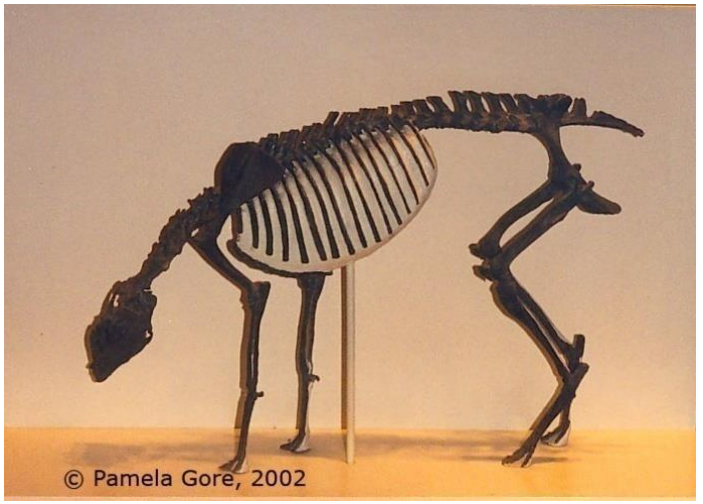


Representative sequence of the horse's evolution

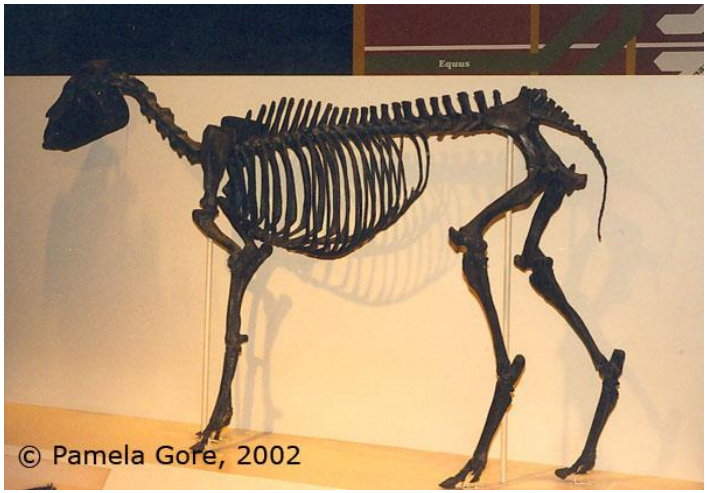
Horse evolution



Hyracotherium, 55 my.



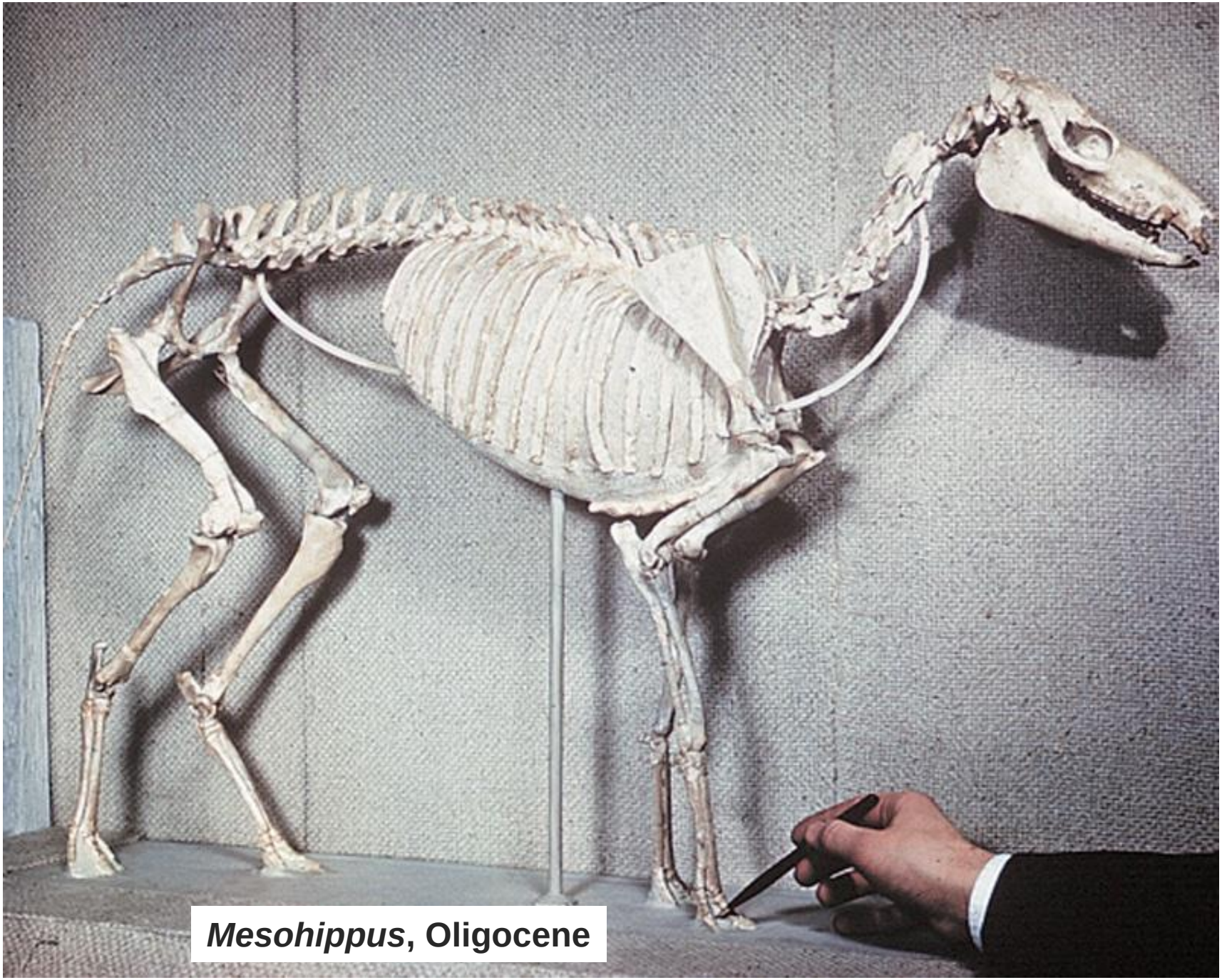
Mesohippus, 40 my

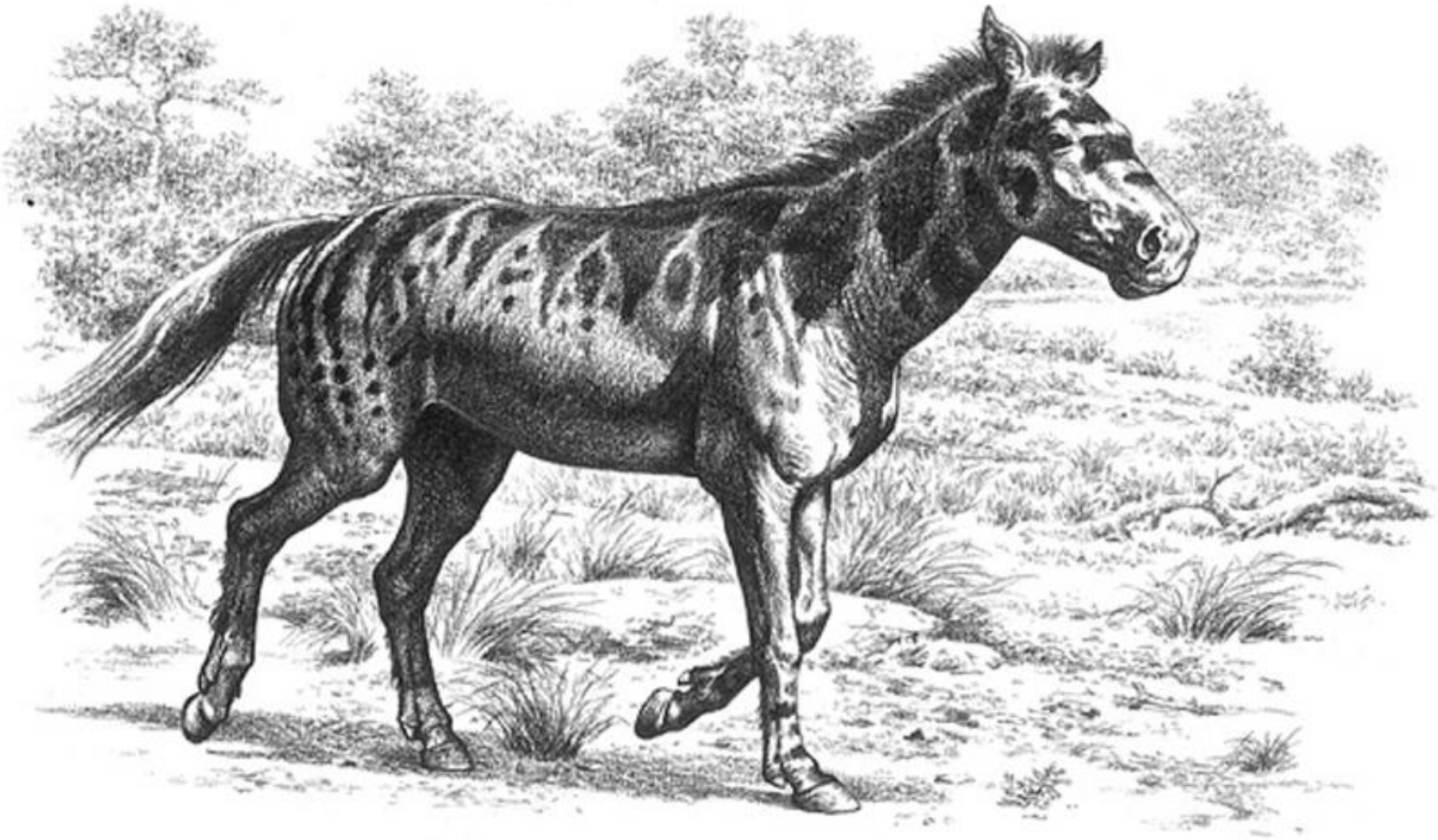


Merychippus, 25 my

Pliohippus, 10 my

***Phenacodus,* Palaeogene, herbivore**


Mesohippus, Oligocene



***Merychippus*, Miocene**

Perissodactyla

Wooly Rhino

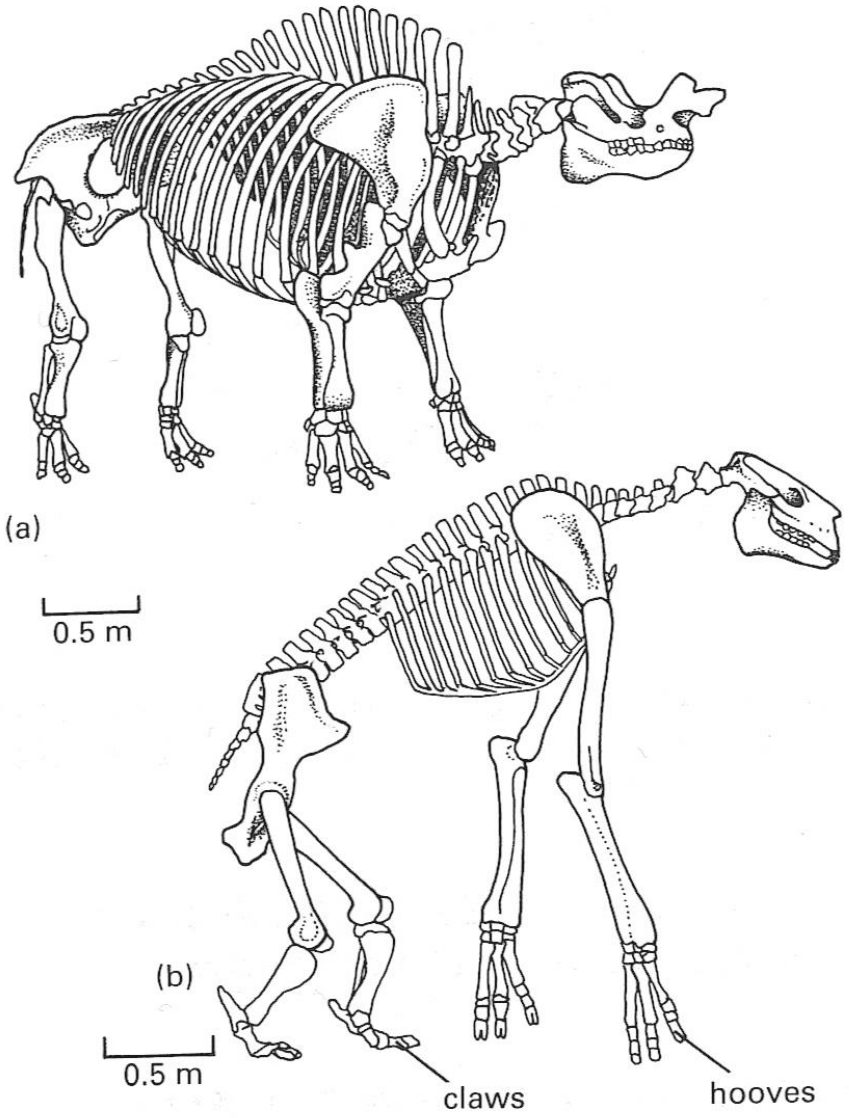
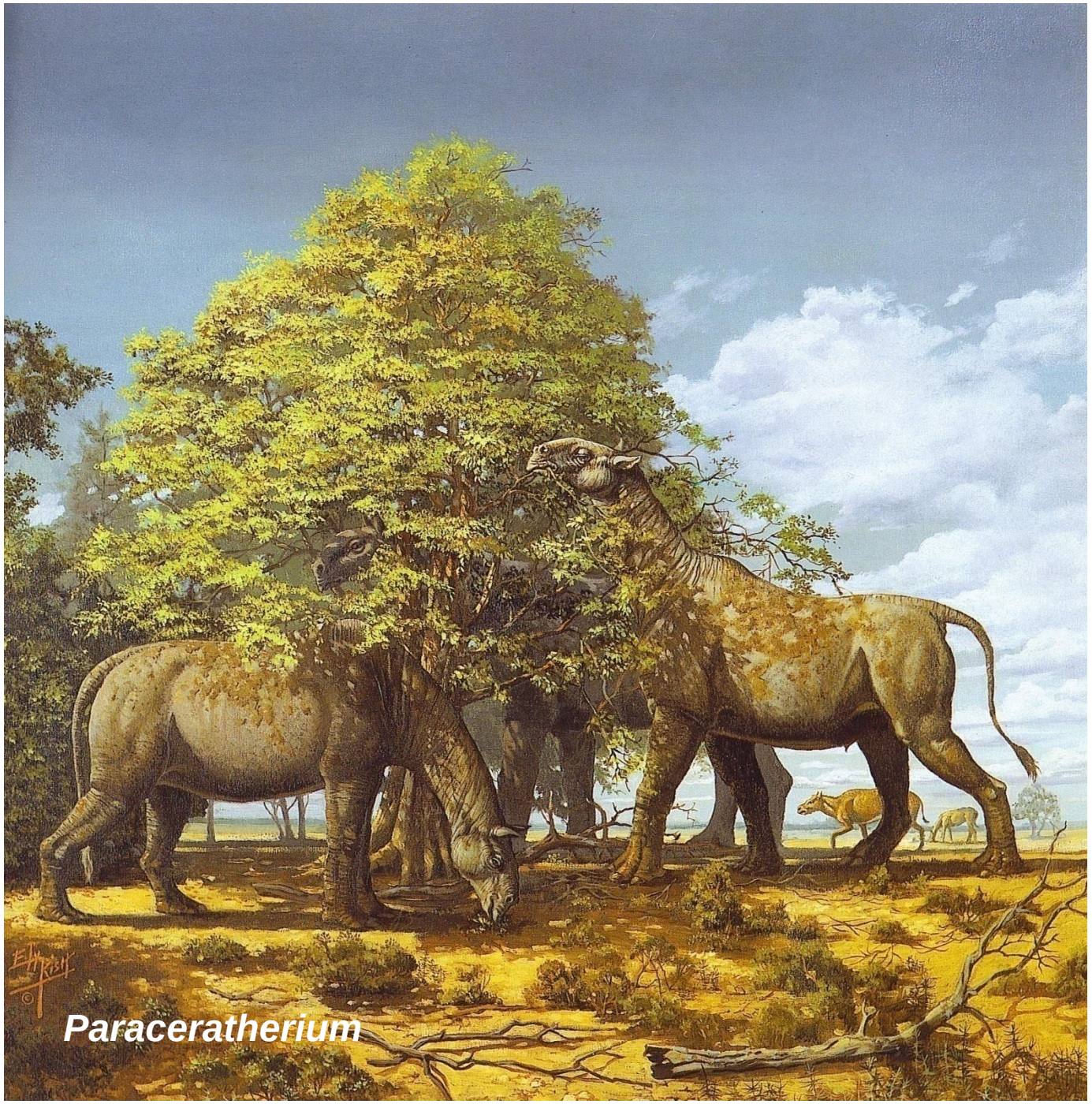


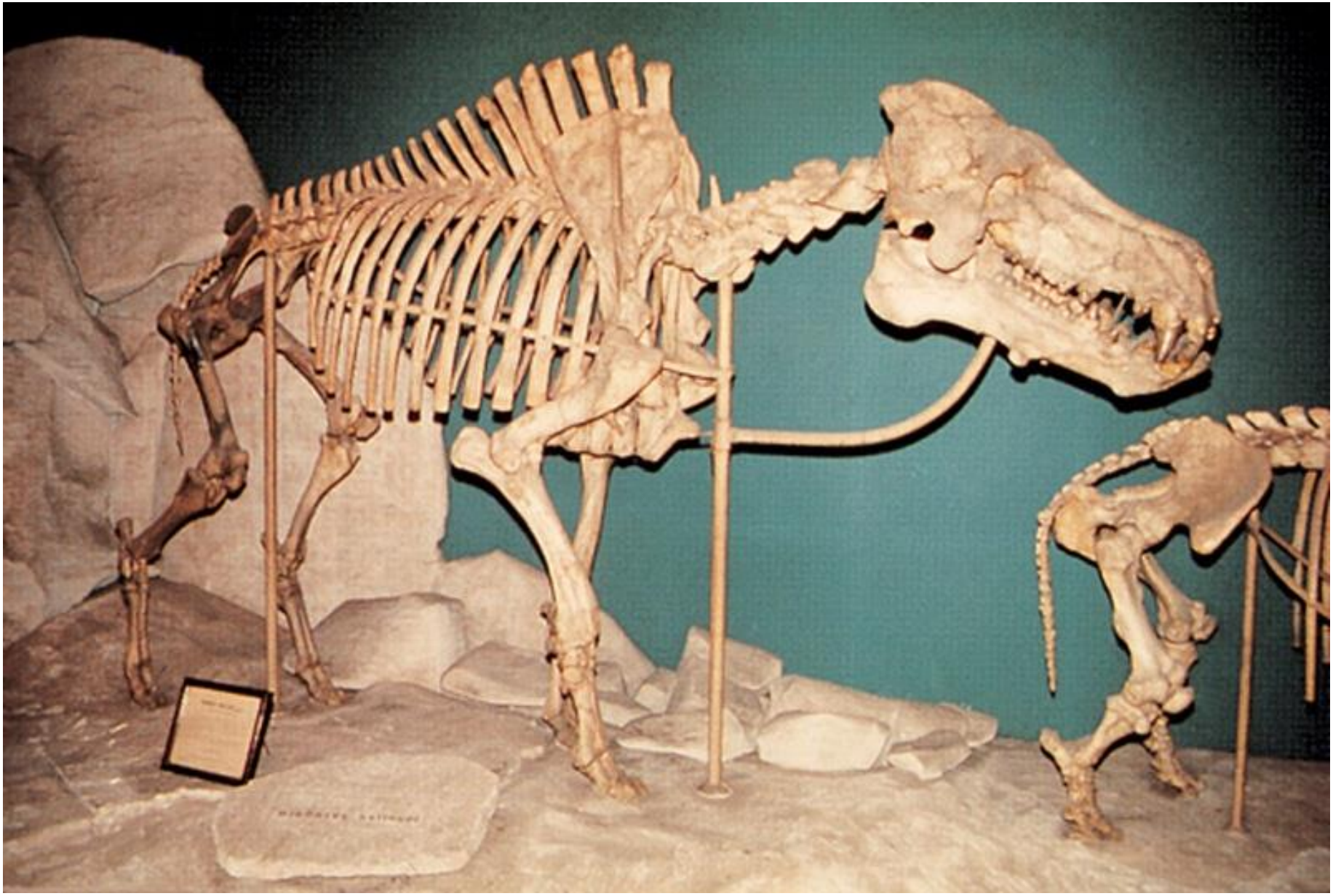
Fig. 10.34 Brontotheres and chalicotheres: (a) the Early Oligocene brontothere *Brontops*; (b) the Miocene chalicothere *Chalicotherium*. [Figure (a) after Scott and Osborn, 1887; (b) after Zapfe, 1979.]


Paraceratherium

Early Miocene

Artiodactyla

- Even number of digits (2 or 4).
- Bovids, pigs, deer, giraffes, camels, hippopotamus, traguloids, musk deers.
- Arthrodactyls include ruminants with multiple stomach chambers and rumination to digest tough food.
- The extinct ones belong to oreodonta, entelodonta and anthracotheria



***Dinohyus*, Miocen entelodont**

Artiodactyla

- The first primitive forms in the Eocene
- From L. Eocene and then two groups:
  - Bunodont, such as pigs,
  - Selenodont, such as deer
- The first were small-sized rather rabbit sized, browsing with 3 or 4 digits.
  Diacodexis from the E. Eocene could be the ancestor to many groups, but has the double talus, typical of the artiodactyls.

Artiodactyla

- The first ruminants were small horned animals, with large canines, common until the E. Miocene when the modern ones started to spread.
- Pecora all possess permanent (bovids horns) or periodic (deer antlers) or bony cranial structures (giraffe ossicones).
- These three forms developed independently and gave the three main types of cranial appendages.

Tethytheria

- The proboscideans, the sirenians, the hyraxes, and some extinct taxa share some derived characters on the skull.

Such as: front position of the orbit above the front premolars and the bunolophodont molars.

- The closest living relatives of proboscideans are sirenians (sea cows).
- Sea cows appeared in E. Eocene and spread from the Eocene to the Miocene.
- The Miocene Dusisiren possesses the characteristic muzzle, the reduced denture, the broad thick pachyosteosclerotic ribs, the fins and the reduced hind limbs.

Metaxytherium medium

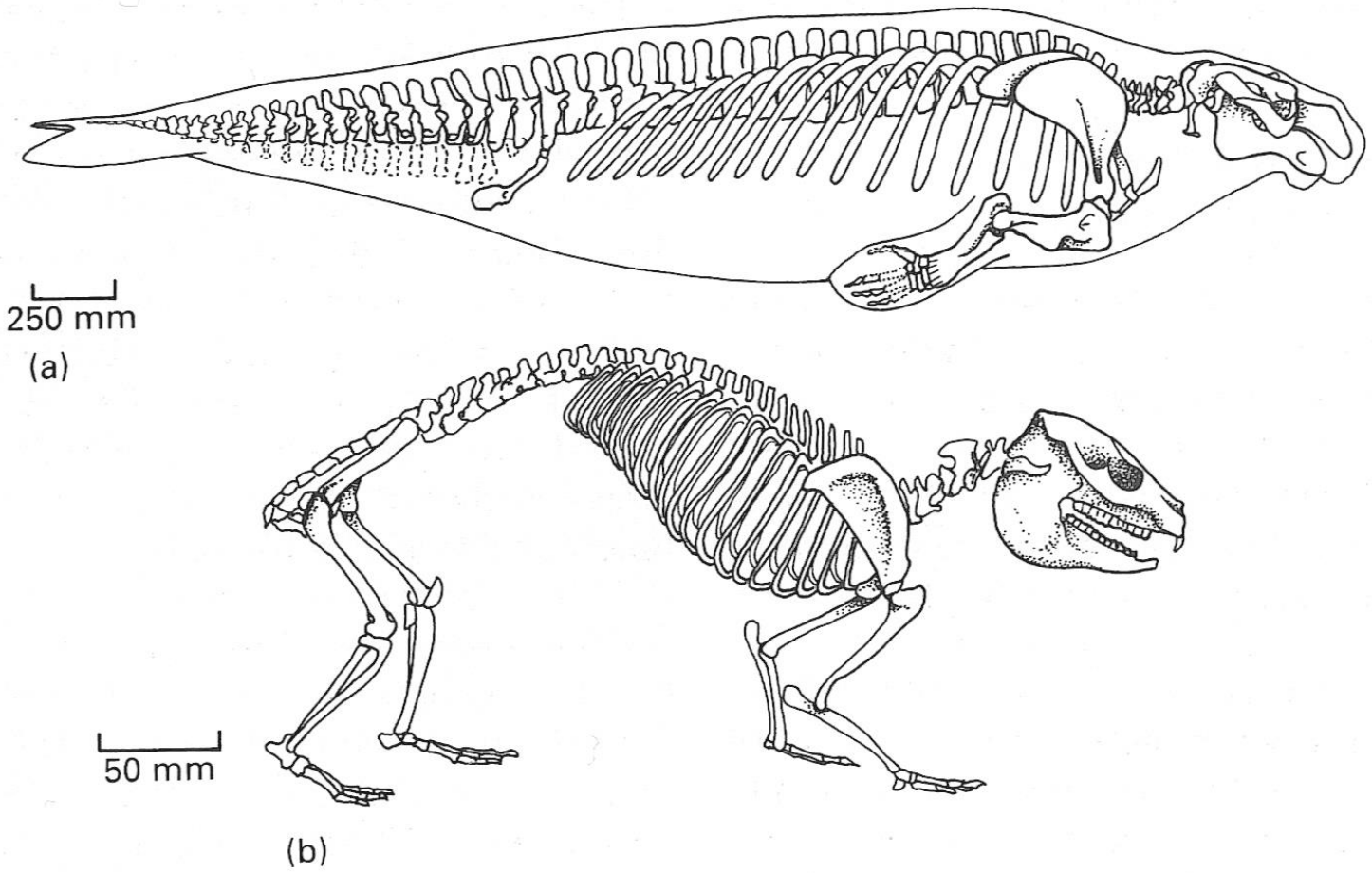
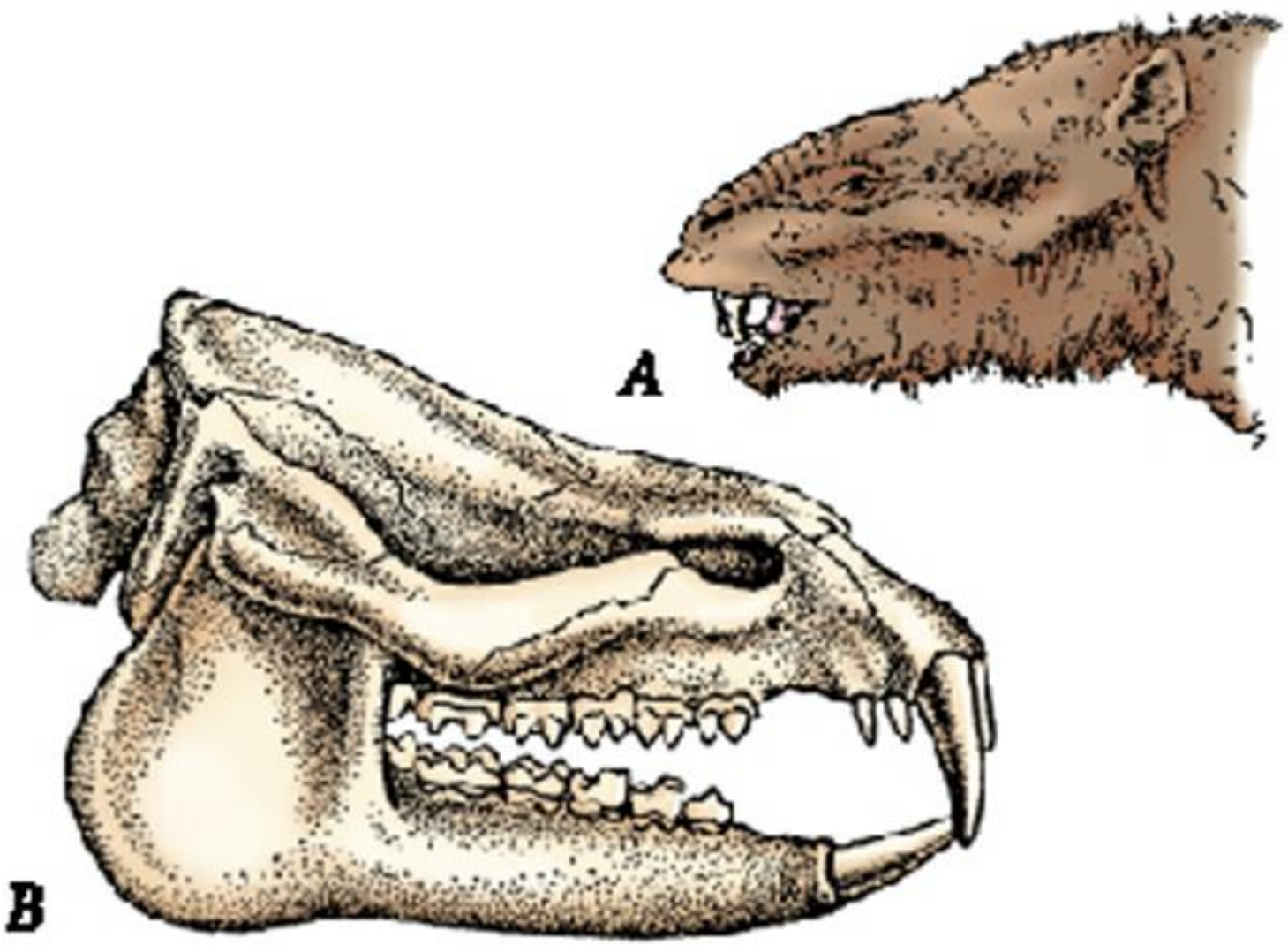


Fig. 10.41 Proboscidean relatives: (a) the Miocene dugong *Dusisiren*; (b) the modern hyrax *Heterohyrax*. [Figure (a) after Domning, 1978; (b) after Young, 1981.]

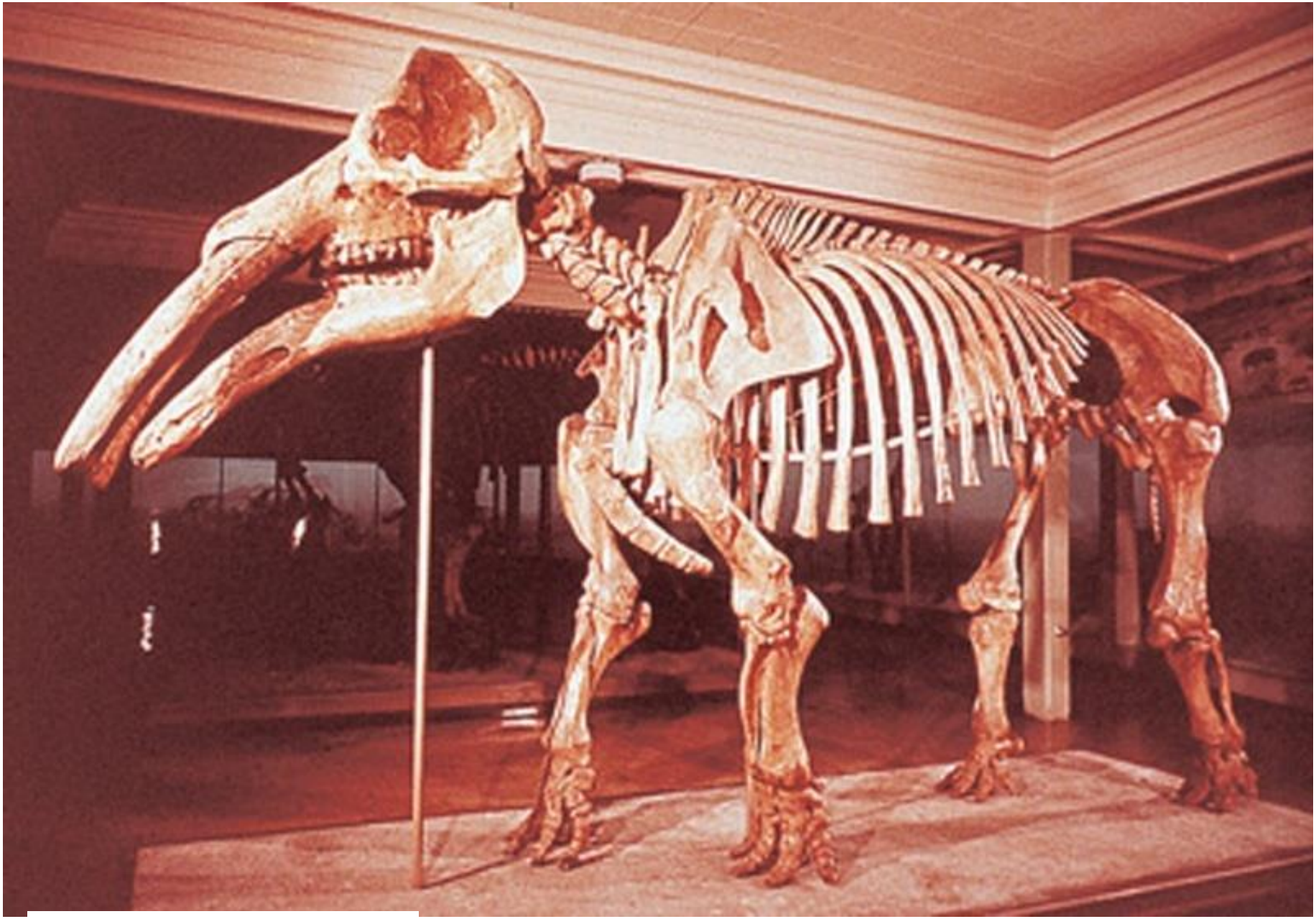
Proboscidea

- The giants on land
- Animals with a trunk (proboscis)
- Elephants, and the extinct, mastodonts, deinotheria, gomphotheria, platybelodonts, stegodonts, etc.
- Phosphaterium was the first representative at the Palaeocene

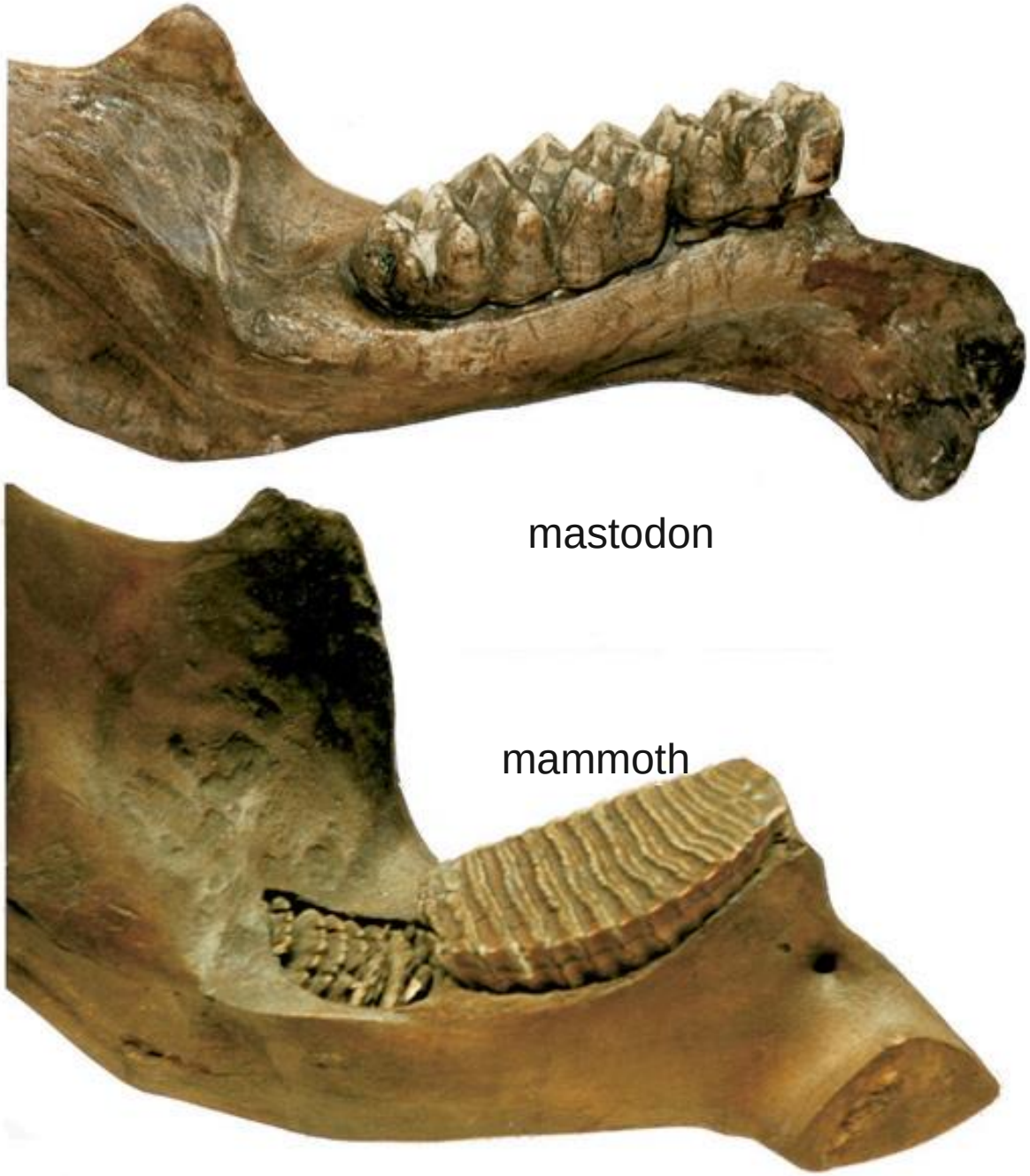
Deinotherium giganteum



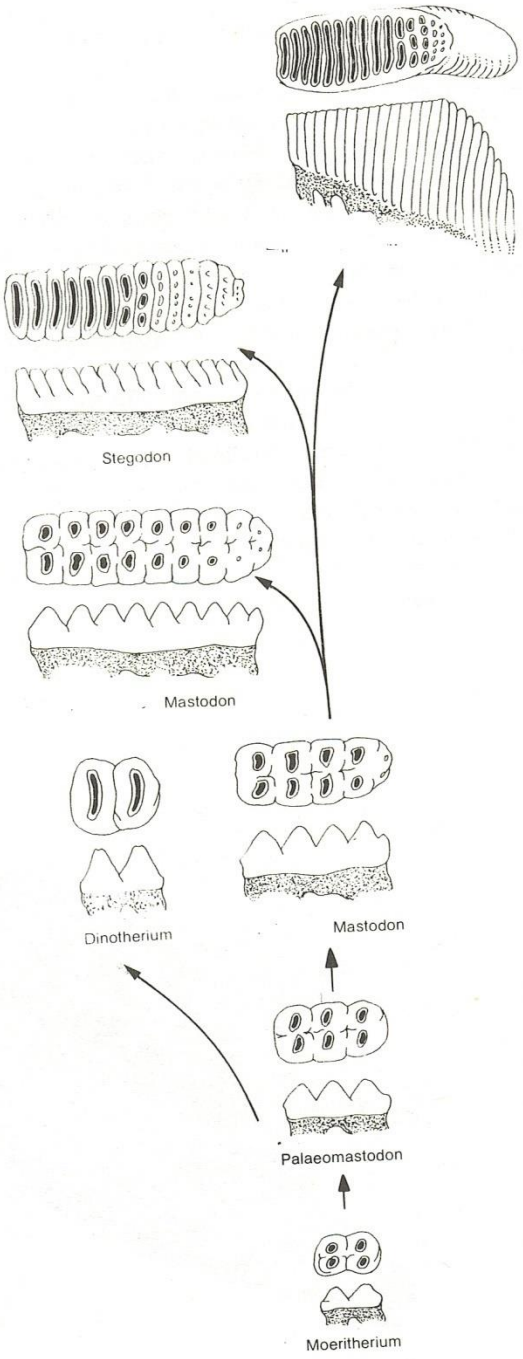
Moeritherium



***Mastodon*, L. Miocene**


mastodon
mammoth

Mammuthus primigenius


Stegodon
Mastodon
Dinotherium
Mastodon
Palaeomastodon
Moeritherium

Cetacea

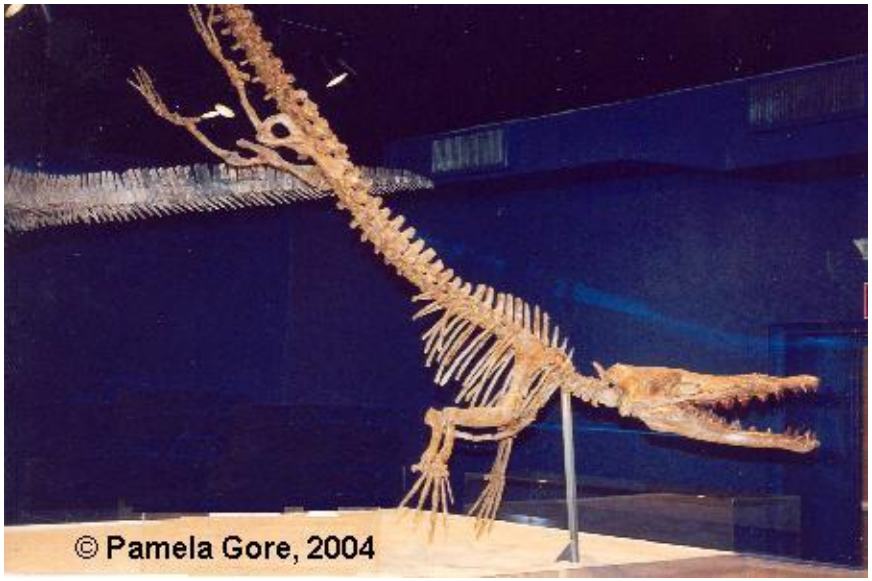
- Mammals fully adapted to sea living, whales (Mysticeti), dolphins (Odontoceti).
- They came from ungulates related to the hippopotamus.

Dolfin

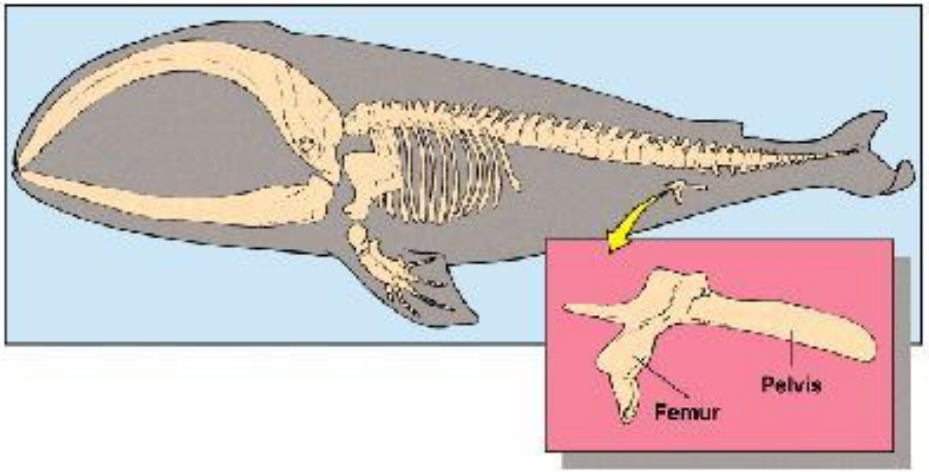
Cetacea

- By Late Eocene times, whales had become fully aquatic and very large.
- *Basilosaurus* is over 20 m long and, unlike modern whales, it must have looked like a classic sea serpent because of its tiny head and long, thin body.
- Its hindlimbs are much reduced, but still present, with all elements in place.
- The pelvis has lost contact with the backbone, and the lower limb and ankle are largely fused.
- This hindlimb would have been useless in swimming, but it may have been used as a copulatory guide.
- The oldest-known whale, *Pakicetus* found in non marine pelites from the Early Eocene of Pakistan, has a long-snouted skull with primitive carnivorous teeth lining its jaws.
- The skeleton of *Pakicetus* is unknown, but a very tentative reconstruction shows a semi-aquatic, coast-dwelling carnivore which could still move on land.

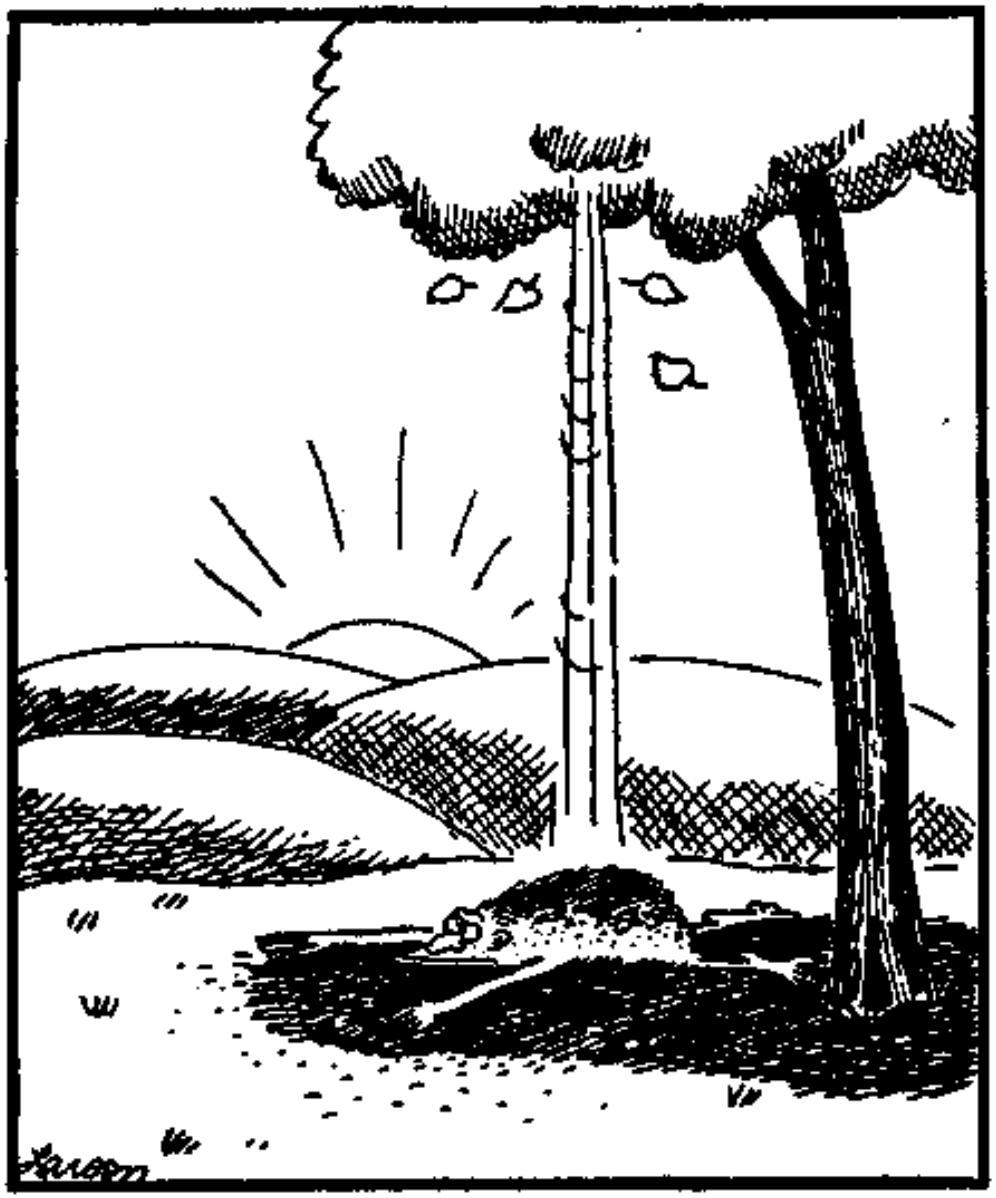
Cetacea with limbs



Georgiacetus vogtlensis, Eocene 42 my.



***Ambulocetus,* Eocene Pakistan**



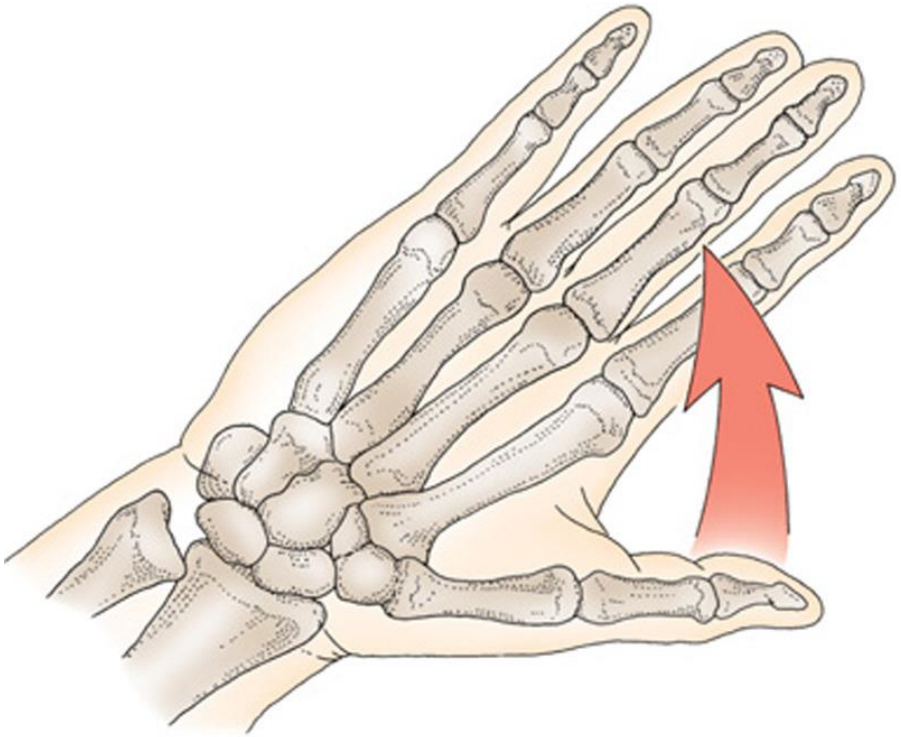
The Dawn of Man

Primates

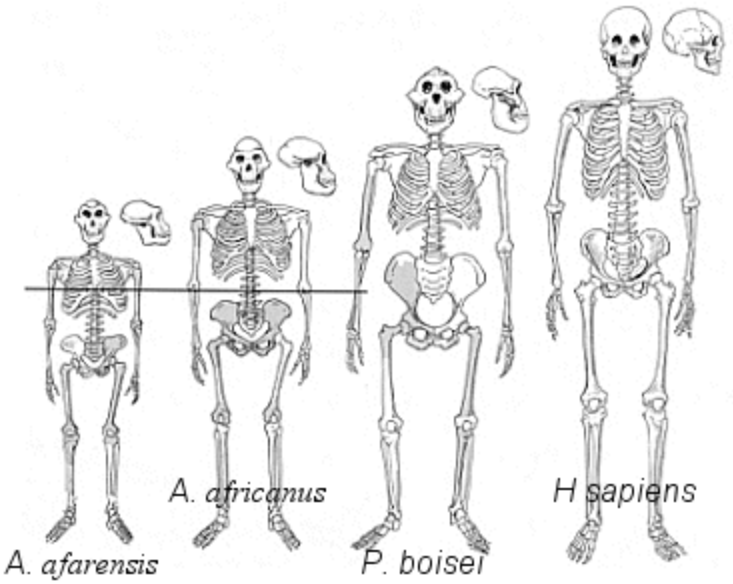
- They are placental mammals
- They have 5 fingers, which is a primitive, non-specialized feature
- They have the general structure of mammals without specific structures such as horns, proboscis etc.

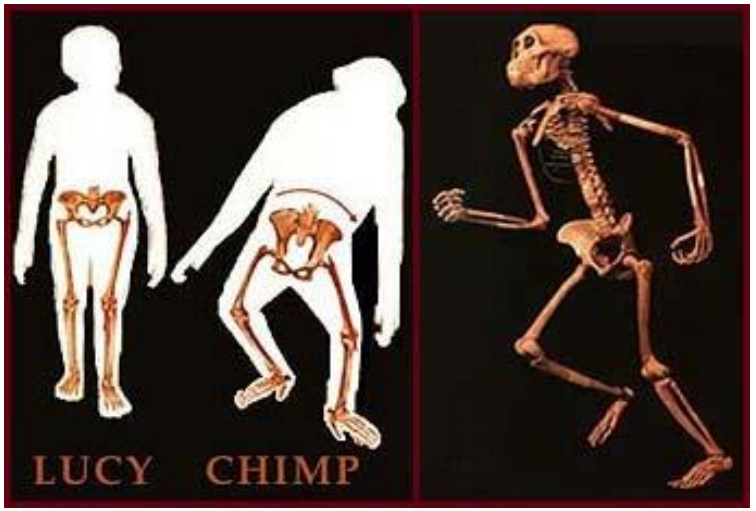
Primate adaptations

- Gradual enlargement of the brain.
- The face becomes shorter and wider.
- Hand Modification - Rear thumb (facing fingers, providing grabing).



- Mobility of the arm to turn the hand.
- Modification of the chest for standing up.
- The front and hind limbs have different structure and function.
- The eyes are generally large and close together on the front of the face, and the snout is reduced.
- Binocular stereoscopic vision. Ability to calculate distance.





Modern Primates

- Modern primates can be classified into four groups:

1. The prosimians, which include lemurs, lorises, and tarsiers
2. New World monkeys, such as the marmosets, spider monkeys, and howler monkeys
3. Old World monkeys, such as macaques, baboons and colobus monkeys
4. The hominoids, which comprise apes and humans.

lemurs

bushbaby

Monkeys

- The higher primates, the monkeys and apes, form a clade, the Anthropoidea
- It is made up from two groups which evolved separately in the New World (mainly South America) and the Old World (Africa, Asia, Europe).
- The New World monkeys, the platyrrhines (broad nose) have broadly-spaced nostrils that face forwards, and some have a prehensile tail.
- The catarrhines, or Old World monkeys and apes, have narrow snouts and non-prehensile tails.
- The two groups had a common ancestor, perhaps in the Early or Middle Eocene

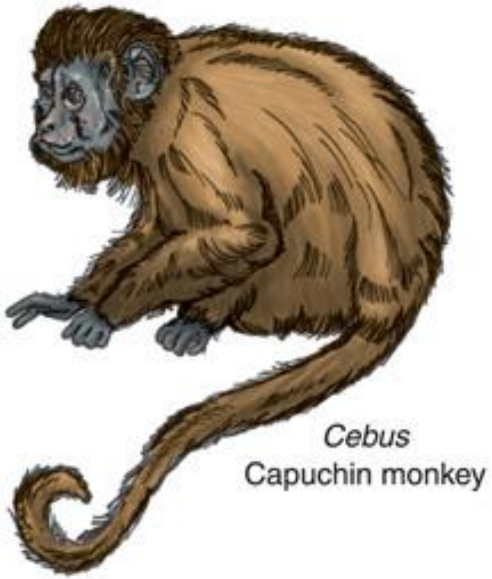
New World monkeys

- They are not included in the evolutionary line of humans
- They include: arachnopithecus, cappuccins and marmosets. Most are small in size
- Tails are used for sensation and movement
- The oldest fossils come from South America and date back to the Oligocene.

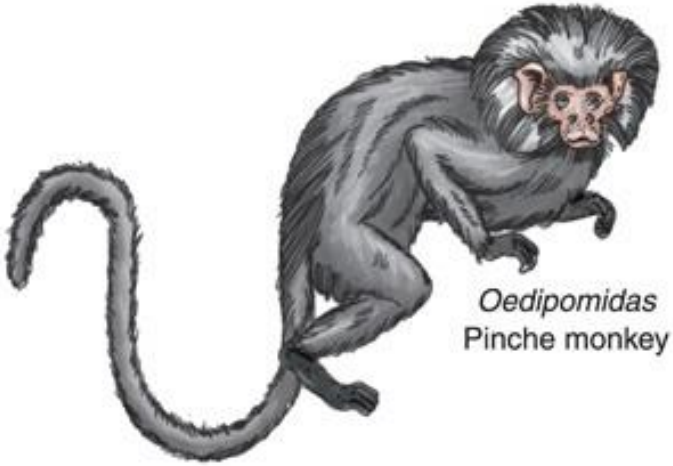
Old World monkeys

- Baboons, mandrills, macaques, colobuses, Barbary apes
- Nostrils close together and in the downward direction, as in humans.
- Tails not used for sense and movement
- The oldest fossils come from Africa and date back to the Paleocene.

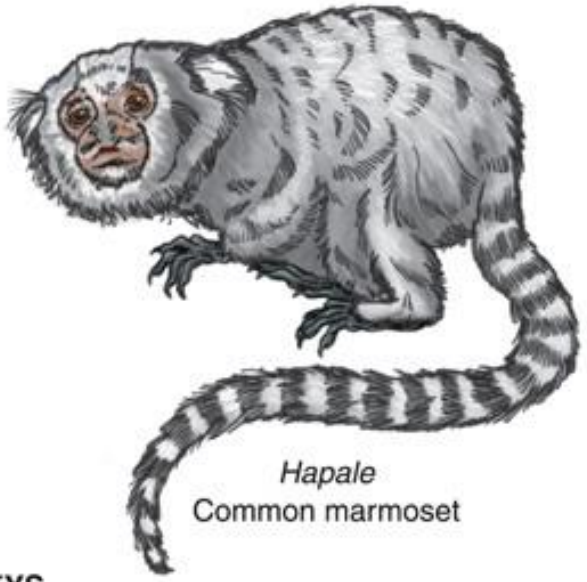
CEBOIDEA: NEW WORLD MONKEYS



Cebus
Capuchin monkey



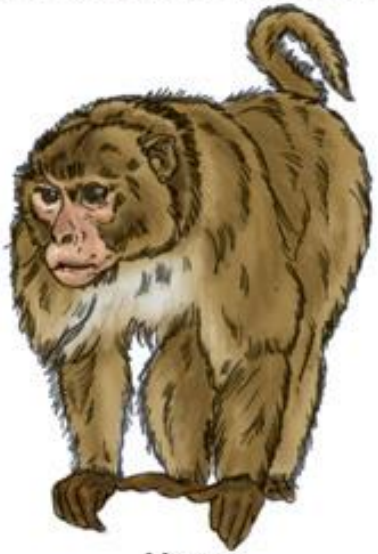
Oedipomidas
Pinche monkey



Hapale
Common marmoset

CERCOPITHECOIDEA: OLD WORLD MONKEYS

Silenus
Wanderoo



Macaca
Macaque monkey

Papio
Baboon

Hominoidea

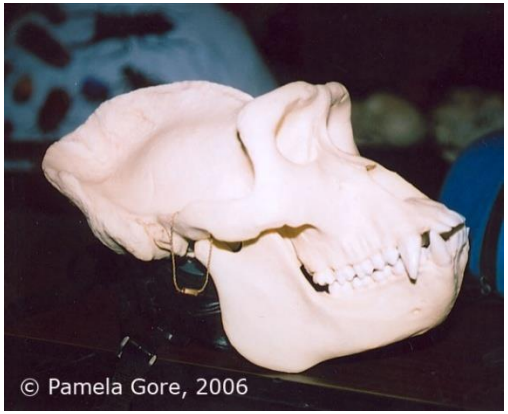
- Primates without tail.
- Gibbons, orangutans, chimpanzees, bonobos, gorillas and humans.
- Extant species and humans have a common ancestor.
- DNA analysis shows that they were separated from humans 5-7 million years ago.
- The DNA of chimpanzees and humans resembles by 98.4%.
  Similarities in hemoglobin and myoglobin indicate that chimpanzees are our closest ancestors.

Hominoidea – modern representatives

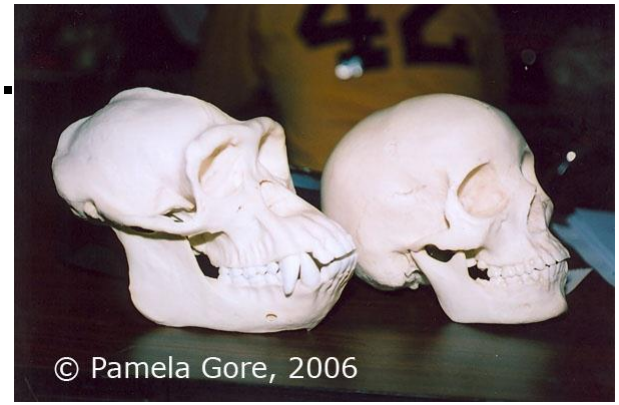
Three families:

- **Hylobatidae** - Gibbons

  The oldest clade of apes without a tail.
- **Pongidae** – orangutans, chimpanzees, bonobos, gorillas.
- **Hominidae** – Humans



Male gorilla skull



Chimpanzee and Human skull

Gibbon

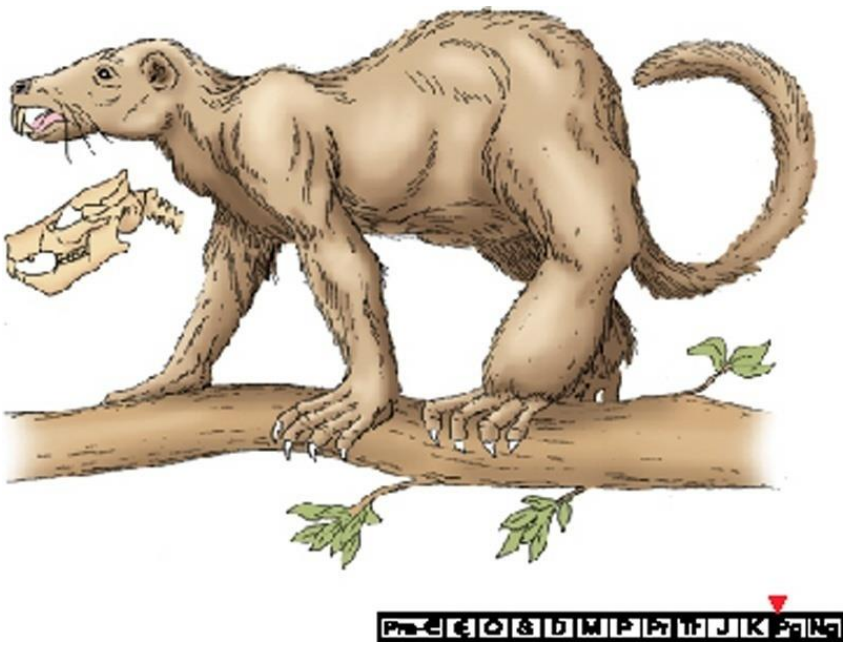
orangutan

gorilla

Chimpanzee

The first prosimians

- The oldest record of the Order Primates is a tooth of a small animal named *Purgatorius* from the Late Cretaceous Hell Creek Formation at Purgatory Hill, Montana. The oldest primates lived together with the dinosaurs.
- The Paleocene Plesiadapis is the only primate, except for Homo, who lived in both the Old and the New World. This shows that Eurasia and America were not completely cut off during the Palaeocene.



The first prosimians

- During the Eocene the primates suffered:
  - Reduction of the length of the face
  - Increase of brain size
  - eyes moved to the front of the face (Front field of correlation)
  - Growth of the big toe for capturing
- Tarsiids and Lemurs were abundant and had a wide distribution throughout the Northern Hemisphere during the Eocene.
- When the climate became cooler, at the Oligocene, the primates disappeared from North America and shifted southwards to Asia, Africa and the East Indies.

The first Hominoidea

- Hominoids are the highest primates - monkeys, apes and humans.
- The first hominoid fossils come from Fayum of Egypt and date back to Oligocene (33-34 my before).
- Aegyptopithecus = sturdy arboreal primate, with monkey-shaped limbs and tail and eyes at the front of the skull.
- The transition from a prosimian to a hominoid occurred in the Oligocene.

Primate evolution

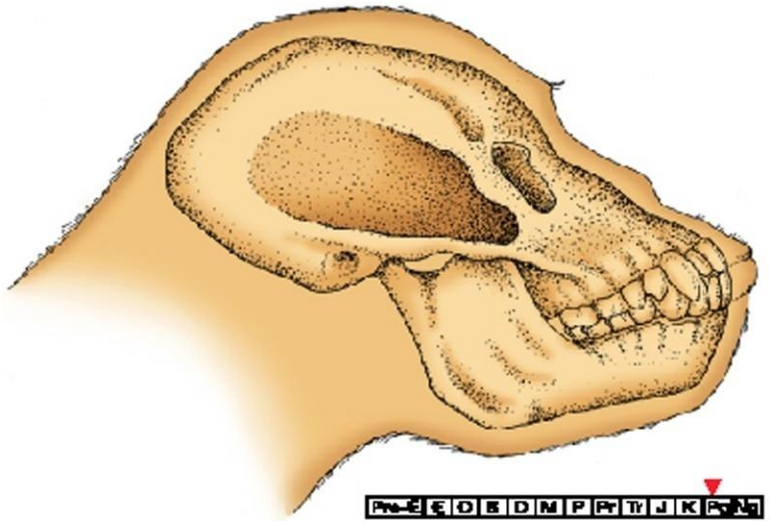
- During the Miocene, plate tectonics influenced the evolution of the primates.
- African and Arabian plates moved north and collided with Eurasia. This changed the flow of Tethys ocean currents, causing the climate in East Africa to become colder and drier.
- The tropical forests were gradually replaced by savannas.

Primate evolution

- Climate and vegetation change has led to the adaptive radiation of the Old World primates.
- At the end of Miocene, the primates that are responsible for the appearance of pongidae (orangutans, chimpanzees, and gorillas) and hominidae (family of humans) appeared.
- A new group, the dryomorphs (former dryopithecines), appeared in the Miocene.

Dryomorphs-Proconsul

- Proconsul, discovered by Leakey in 1948 in Kenya, was a dryomorph or ancestor of the dryomorphs.
- He had a monkey skull, jaw and teeth. He had a monkey-shaped long trunk, forelimbs and finger phalanges.
- Proconsul's descendants in the Middle Miocene are probably the ancestors of extant African monkeys and the first hominids, Australopithecines.



Primate evolution

- About 18 my ago, Africa collided with Eurasia. Primates moved to Eurasia and diversified.
- These primates include the following Miocene apes, called Ramamorphs, and are considered as ancestral forms of extant apes and humans:
  - Ramapithecus
  - Sivapithecus
  - Gigantopithecus (Yeti?)

European apes

- *Dryopithecus laietanus*: Can Llobateres Spain. M. Miocene.
- *Dryopithecus brancoi*: Rudabania Hungary. M. Miocene (12-10 my).
  Griphopithecus spp .: Slovakia and Turkey. M.Miocene.
  Oreopithecus bamboli: Italy. Island endemic species. Upper Miocene (9.5-6.5 million years ago).
- *Ancaropithecus meteai*: Turkey. L. Miocene.
- *Ouranopithecus macedoniensis*: the valley of Axios and Nikiti of Chalkidiki. Upper Miocene (9.5-8 my).
- *Graecopithecus freybergi*: Vassilissis Attica (after 8 my)

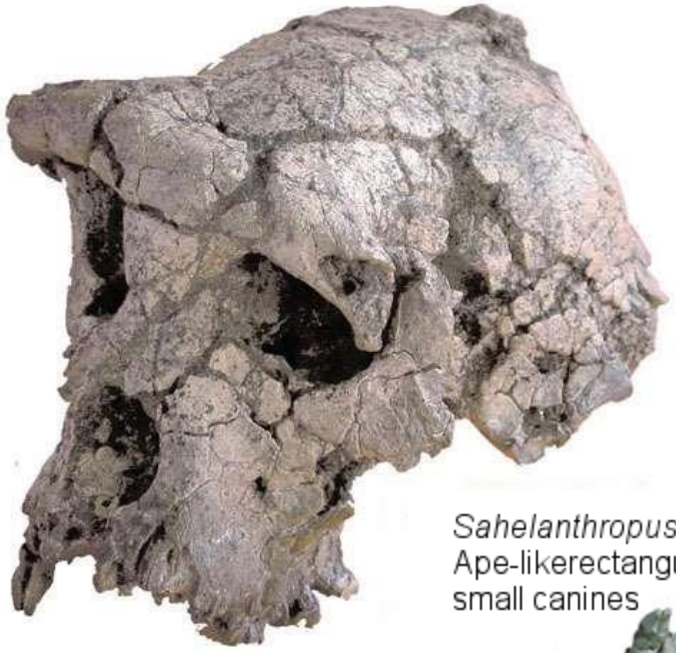
Australopithecines

- *Australopithecus africanus* was discovered in 1924 by Raymond Dart in South Africa. Since then, several Australopithecus samples have been discovered in East Africa.
- East African fossil sites have revealed hundreds of bones of human beings, giving light to the human evolution of the last 4 million years.
- Enclosed volcanic ash allows the dating of hominid fossils .

Australopithecus africanus

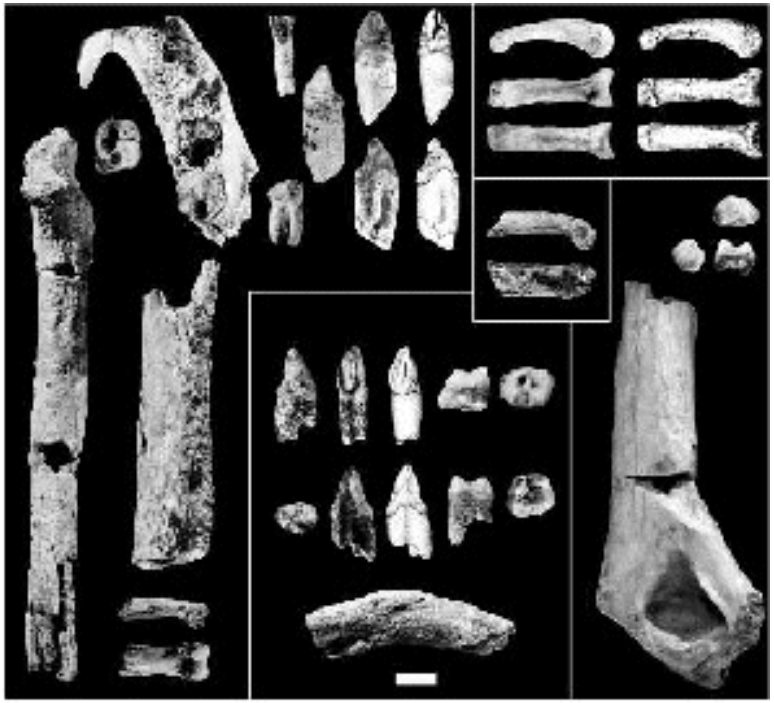
The oldest fossils

- The oldest hominid fossil is considered *Sahelanthropus tchadensis*, found in Chad and dating 6 to 7 my.
- Prior to this discovery, older was considered *Ardipithecus ramidus* (5.8 - 5.2 my) from Ethiopia.
- *Australopithecus anamensis* lived 4.2 to 3.9 my. It appears to be an intermediate link between *Ardipithecus ramidus* and *Australopithecus afarensis* or "Lucy".

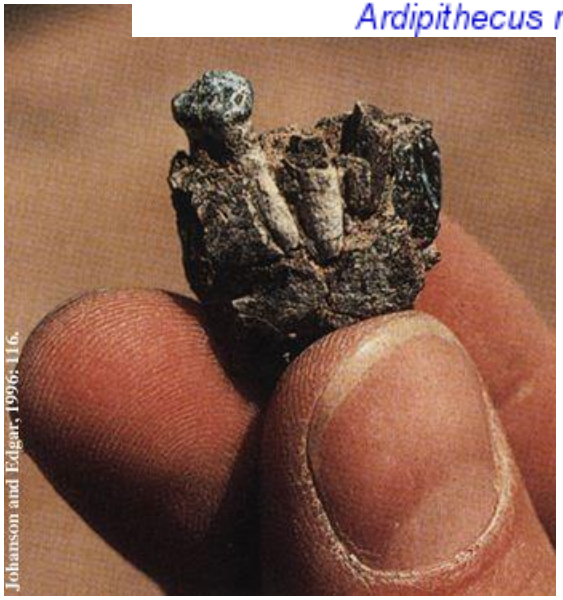


Sahelanthropus tchadensis
Ape-likerectangular jaw
small canines

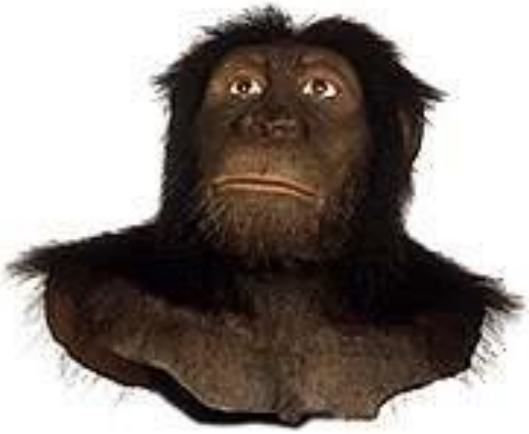
Sahelanthropus tchadensis
6 - 7 my

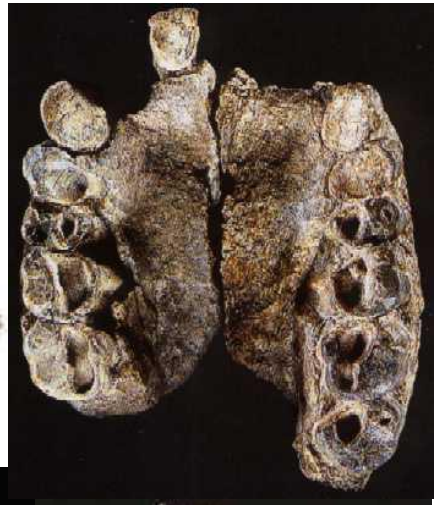


Ardipithecus ramidus



Ardipithecus ramidus
5.8 - 5.2 my



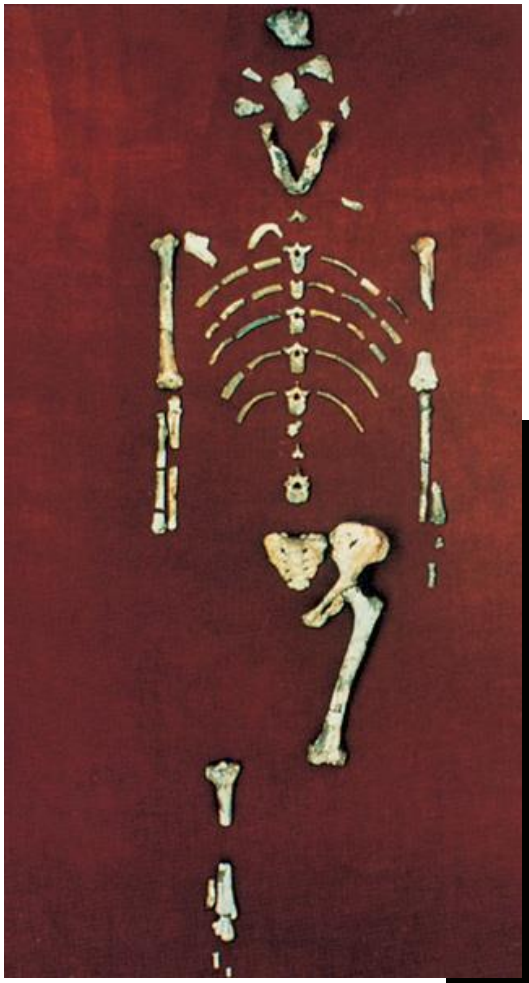


Ardipithecus ramidus
5.8 - 5.2 my

Australopithecus anamensis
4.2 - 3.9 my.

Australopithecus afarensis
3.5 my.

"Lucy"
Australopithecus afarensis

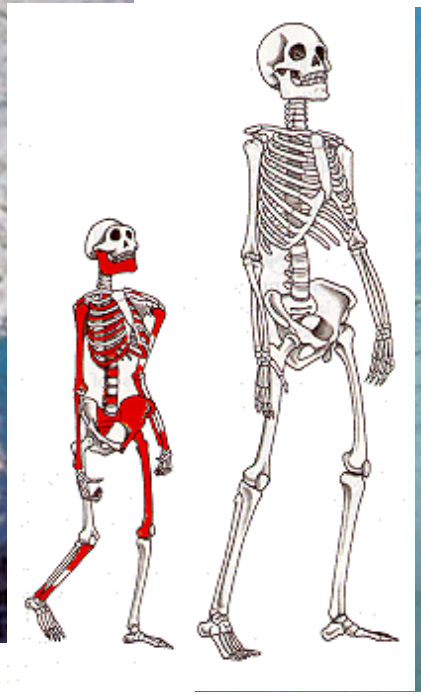


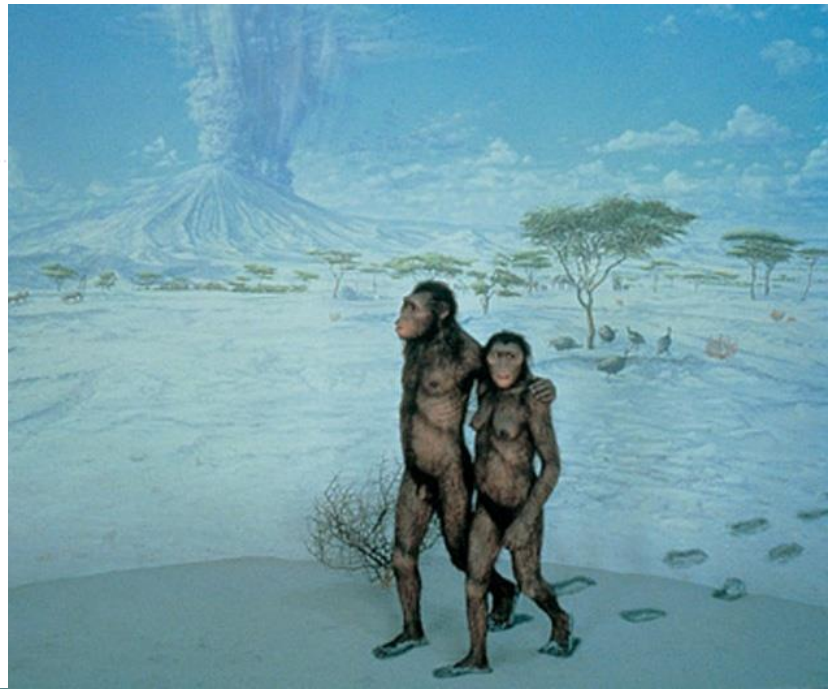
- It was discovered by Donald Johanson in 1974 and was named "Lucy".

- Lucy was an bipedal hominid, lived in East Africa about 3.5 my. The upright position is confirmed by analysis of pelvic and hind limb bones.

"Lucy"
Australopithecus afarensis

Additional proof of bipedalism is footprints found on volcanic rock in Laetoli, West Africa, and date back to 3.2 million years ago.





"Lucy"
Australopithecus afarensis

The dentition is very similar to humans.

The cranial cavity was smaller than modern people.
(600 cm^3 versus 1400-1600 cm^3 for modern humans).

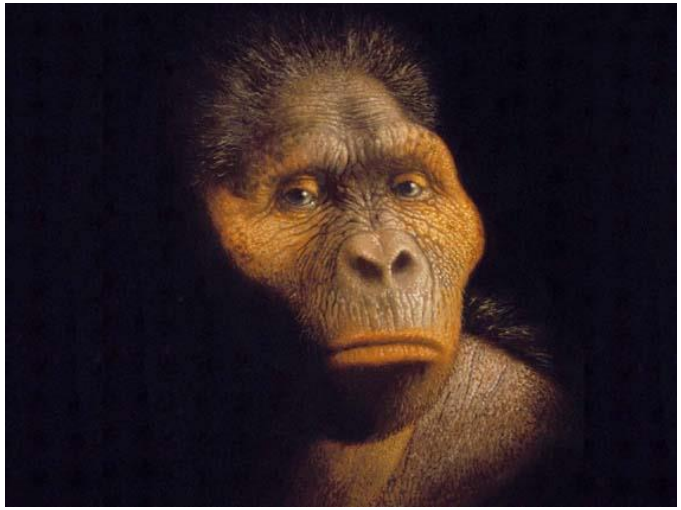
Australopithecus sediba

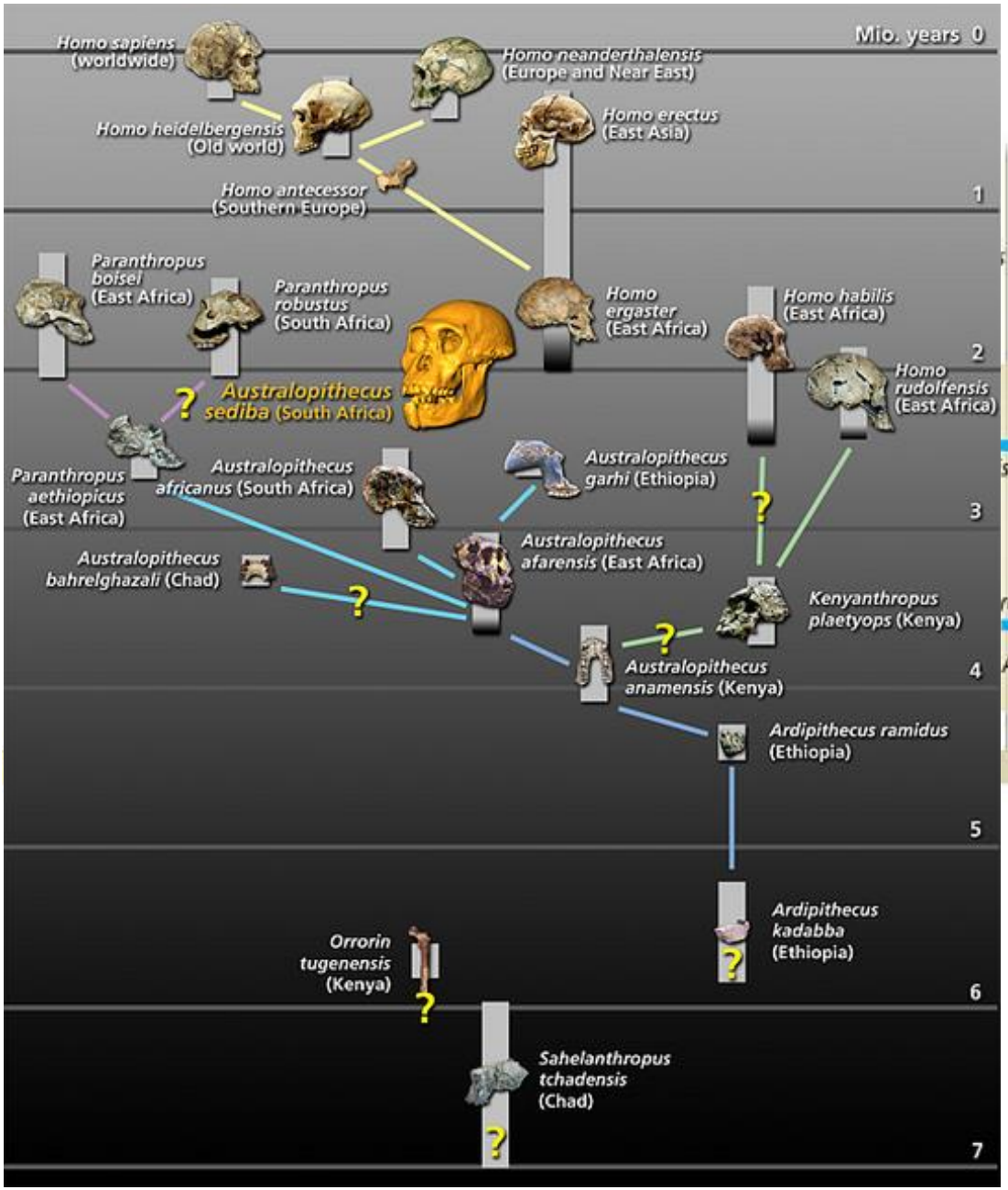
- In 2010 a new find from South Africa (Malapa) with an age of 2 my and more similar to the genus Homo and large brain

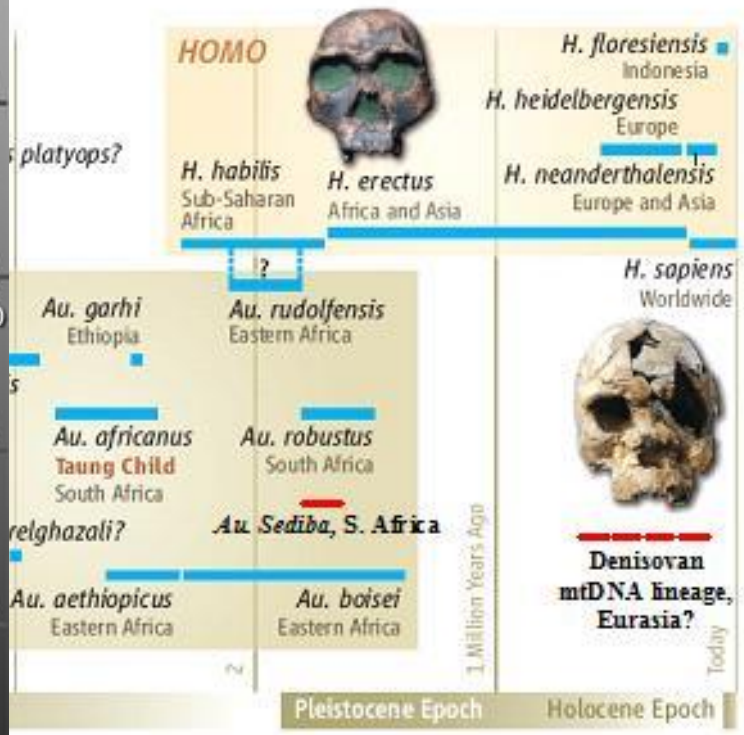
Two types of Australopithecines

- Gracile – Smaller, lighter with smaller teeth. Includes *Australopithecus africanus* and *Australopithecus afarensis* (Lucy).This group gave the genus Homo.
- Robust – Larger, heavier with bigger teeth. Includes *Australopithecus boisei* (or *Paranthropus boisei*) and *Australopithecus robustus* (or *Paranthropus robustus*). Both are parallel evolutionary clades

- Two views whether *A. boisei* and *A. robustus* belong to the genus Australopithecus.
- The modern view of the scientific community is that they should be placed in a different genus, Paranthropus, which seems to have come from the Australopithecines. The robust Australopithecus are placed now at the genus Paranthropus..
-



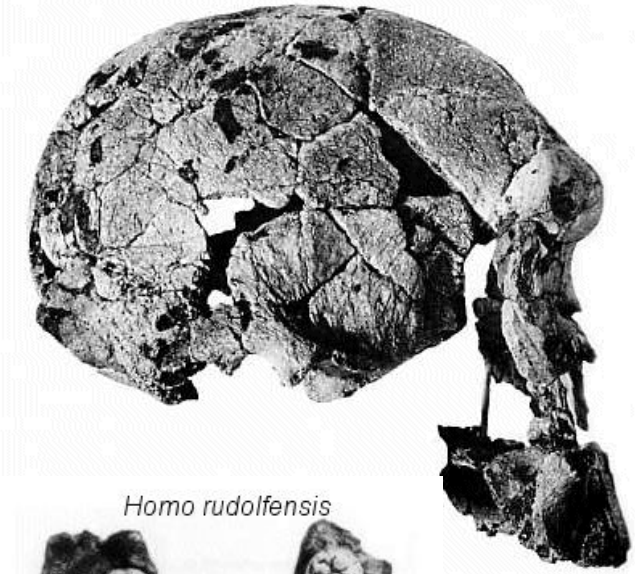

Mio. years 0
Homo sapiens (worldwide)
Homo neanderthalensis (Europe and Near East)
Homo heidelbergensis (Old world)
Homo erectus (East Asia)
Homo antecessor (Southern Europe)
1
Paranthropus boisei (East Africa)
Paranthropus robustus (South Africa)
Homo ergaster (East Africa)
Homo habilis (East Africa)
Homo rudolfensis (East Africa)
2
? Australopithecus sediba (South Africa)
Paranthropus aethiopicus (East Africa)
Australopithecus africanus (South Africa)
Australopithecus garhi (Ethiopia)
3
Australopithecus bahrelghazali (Chad)
Australopithecus afarensis (East Africa)
Kenyanthropus platyops (Kenya)
Australopithecus anamensis (Kenya)
4
Ardipithecus ramidus (Ethiopia)
5
Ardipithecus kadabba (Ethiopia)
Orrorin tugenensis (Kenya)
6
Sahelanthropus tchadensis (Chad)
7


HOMO
H. floresiensis
Indonesia
H. heidelbergensis
Europe
platyops?
H. habilis
Sub-Saharan Africa
H. erectus
Africa and Asia
H. neanderthalensis
Europe and Asia
?
H. sapiens
Worldwide
Au. garhi
Ethiopia
Au. rudolfensis
Eastern Africa
Au. africanus
Taung Child
South Africa
Au. robustus
South Africa
relghazali?
Au. Sediba, S. Africa
Au. aethiopicus
Eastern Africa
Au. boisei
Eastern Africa
Denisovan mtDNA lineage, Eurasia?
2
1 Million Years Ago
Today
Pleistocene Epoch
Holocene Epoch

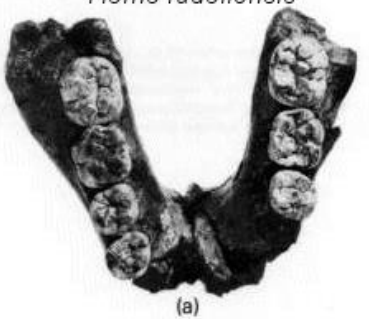
Homo

- The genus Homo appeared about 2.5 my, when Australopithecines evolved into the ancestor of humans, the *Homo ergaster*, (or *Homo habilis*).
  Homo rudolfensis and *Homo ergaster* or *Homo habilis* lived in Africa about 2 - 2.5 my.

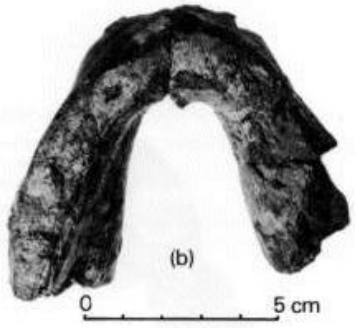
Homo rudolfensis



Homo rudolfensis

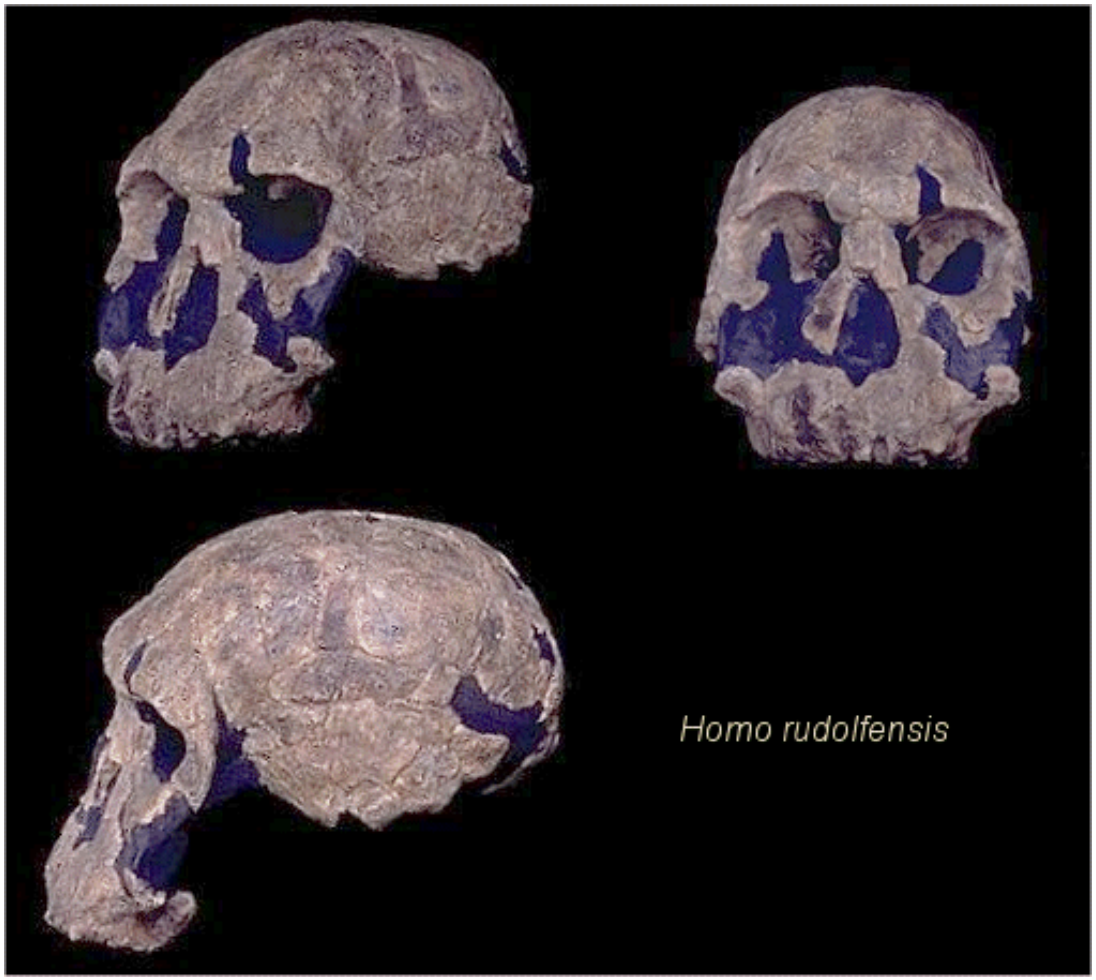


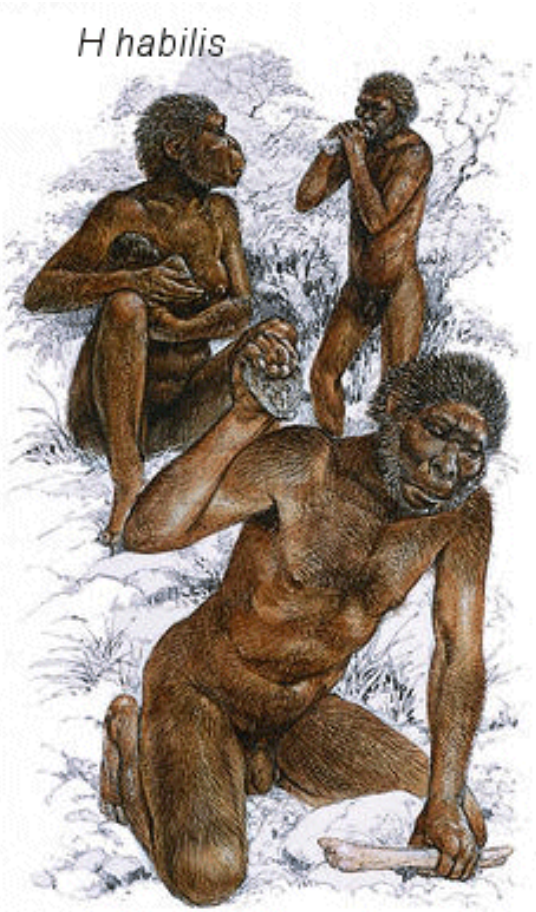
(a)



(b)

0 5 cm





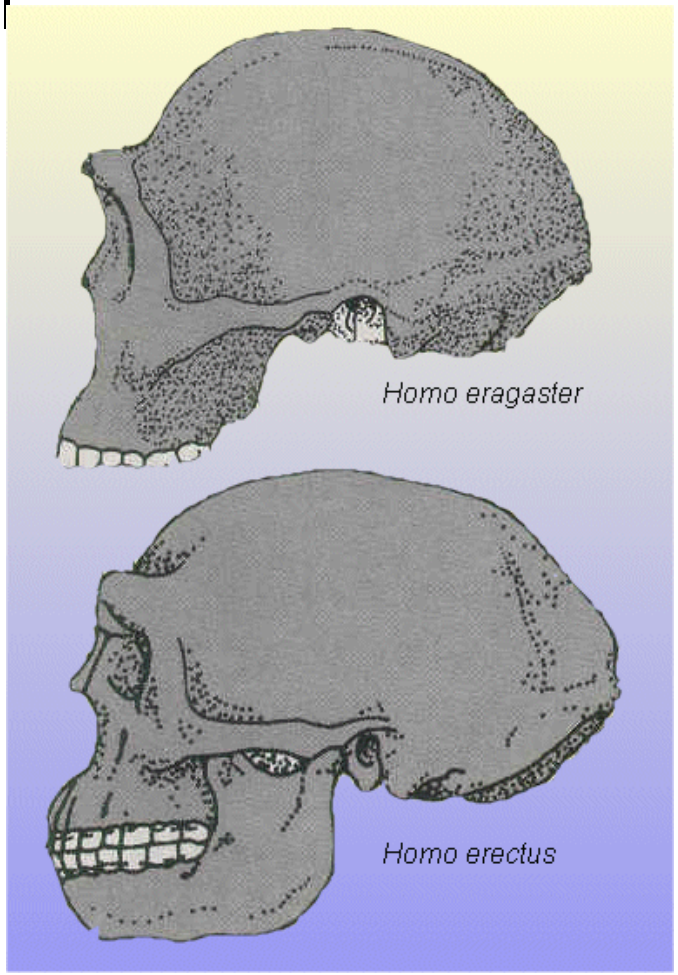
Homo ergaster
ή
Homo habilis

Homo

- The evolutionary transition may have begun with a climate change to colder and drier than conditions about 2.7 million years ago.
- The tropical forests were gradually replaced by savannas.
- In this context, ecological pressures led to bipedalism, to greater intelligence and the ability to make stone tools. Stone tools are found along with Homo fossils.

Homo

- The genus Homo has a larger cranial cavity and smaller teeth, but no apparent anatomical differences.
- *Homo erectus* originated either from *Homo ergaster* or *Homo habilis*.

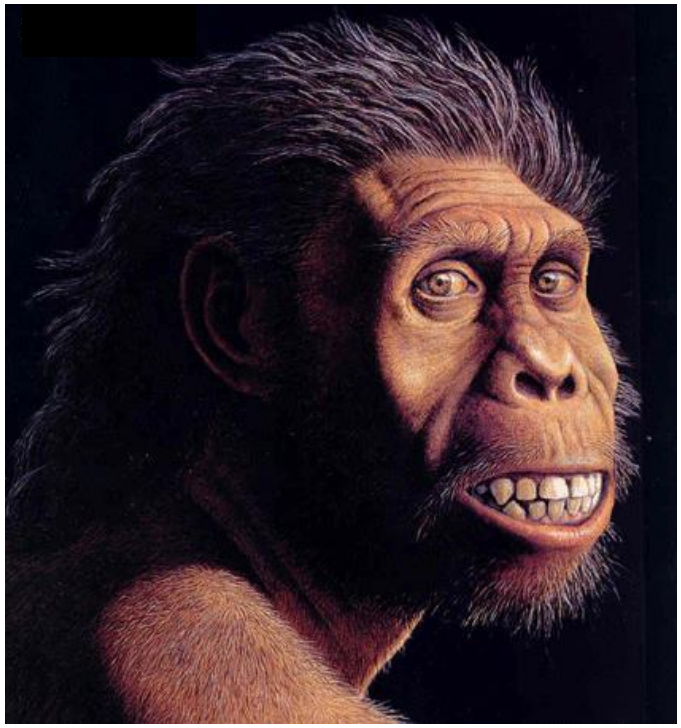


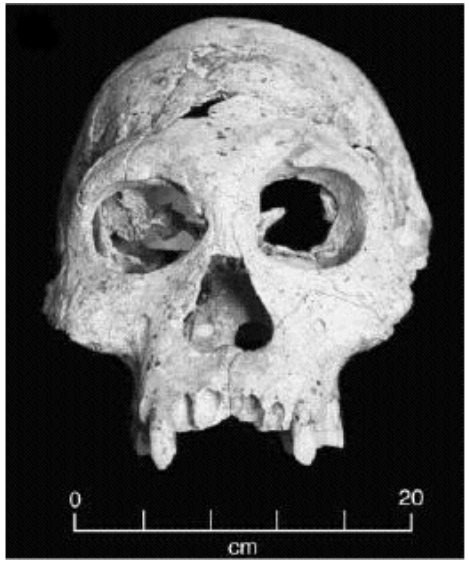
Homo erectus (left) and Australopithecus afarensis (right)

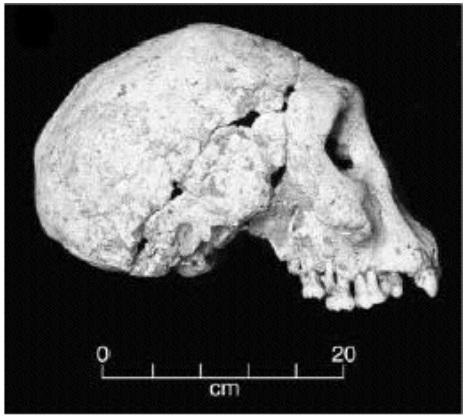
Homo erectus stage

- The fossils of *Homo erectus* include:
  - Cranial material 1.8 my from the Caucasus Mountains in Georgia (*Homo georgicus*)
  - A complete skeleton of 1.5 my from East Africa near Lake Turkana (long limbs, tall and thin with great resemblance to modern humans)
  - A 750,000 year old cranial test from the Olduvai Gorge.

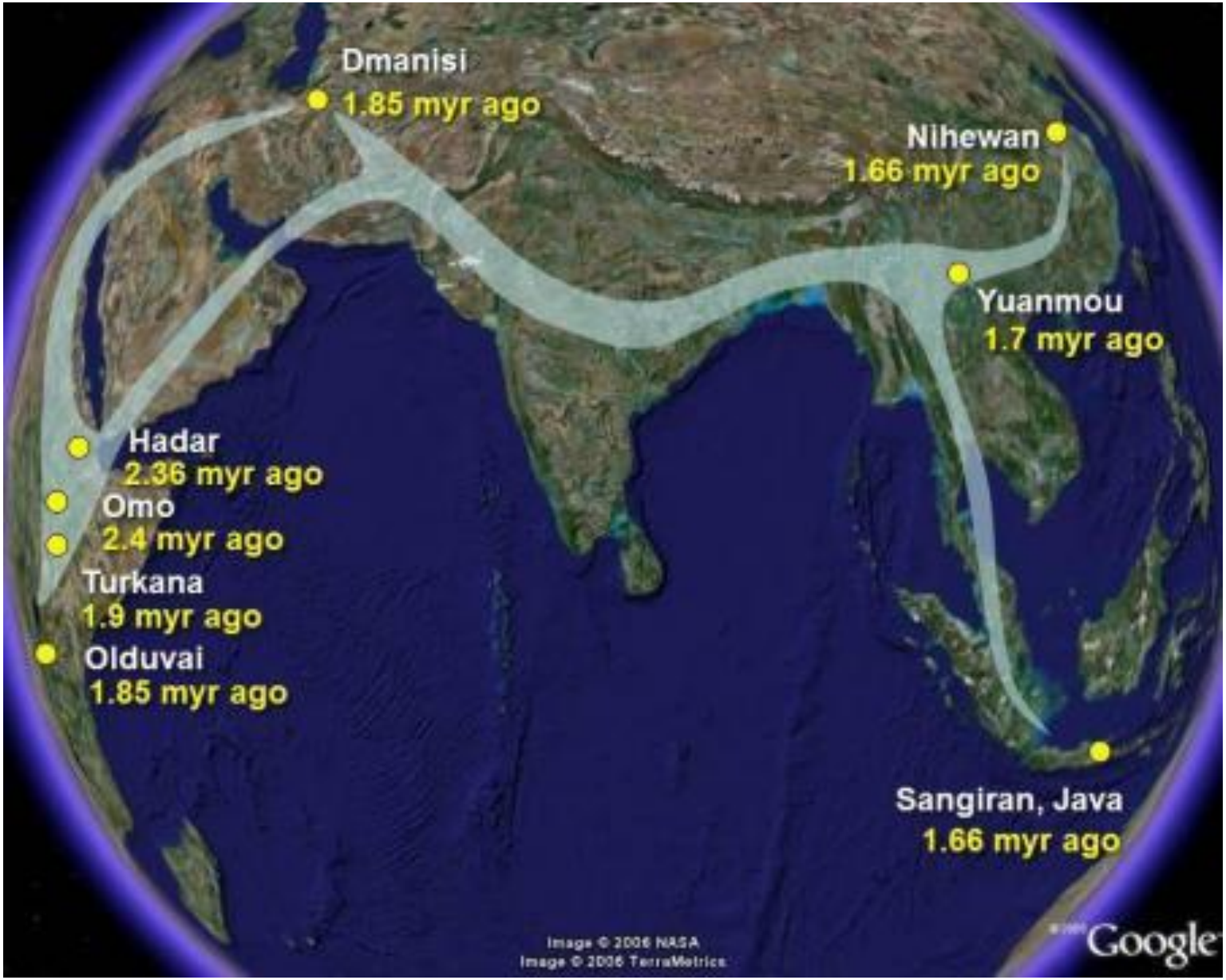
Homo georgicus







- *Homo erectus* lived in the Lower and Middle Pleistocene
- *Homo erectus* is the first hominid that moved out of Africa.
- *Homo erectus* began a rapid increase in brain size.
- *Homo erectus* was a tool manufacturer and hunter. It is unclear if they could speak, if they were wearing clothes, dwelling, or using fire.


Dmanisi
1.85 myr ago
Nihewan
1.66 myr ago
Yuanmou
1.7 myr ago
Hadar
2.36 myr ago
Omo
2.4 myr ago
Turkana
1.9 myr ago
Olduvai
1.85 myr ago
Sangiran, Java
1.66 myr ago
Image © 2006 NASA
Image © 2006 TerraMetrics
Google

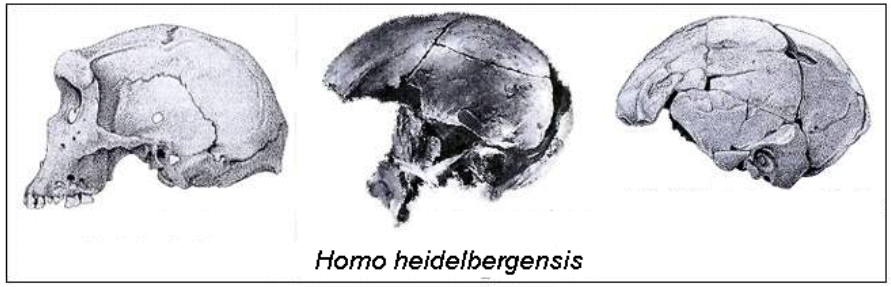
- Cranial capacity 775 - 1300 cm^3, slightly smaller than modern humans.
  Skull relatively bulky and flattened.
  Over-sized and bony superorbital arches.
  Bent forehead.
  Projected jaws.
  Nose wide and flattened.
  Teeth bulky but in modern form.
  No protruding chin.

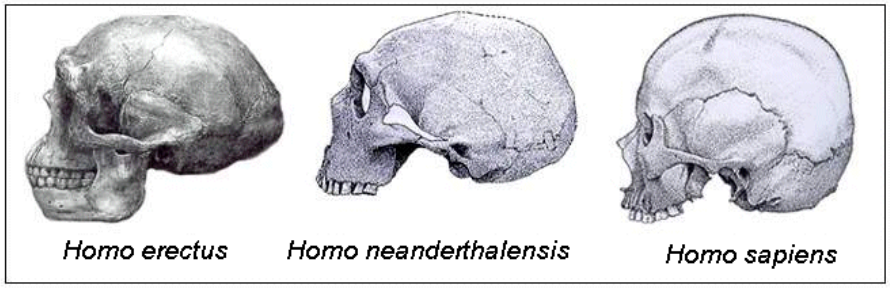
Homo heidelbergensis

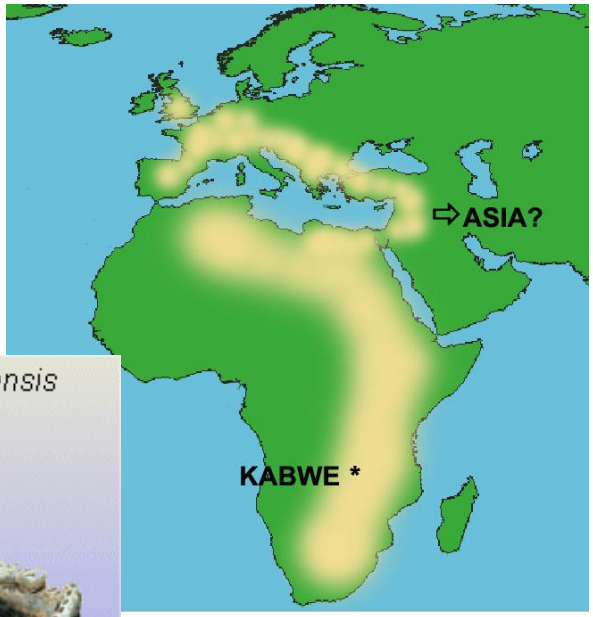
- It is a pre-sapiens form, with typical features of *H. erectus* and *H. sapiens*. They were formerly known as archaic *H. sapiens*.
- They have been found in Europe (Germany, England, Spain), the Middle East and Africa.
- They lived between 780 000 and 100 000 years ago.

- In Greece he has been found in Petralona, Halkidiki (Petralona Man) and dates back about 250,000 years ago, Apidima of Laconia.

- This is a group of people who moved out of Africa to Europe after the migration of *H. erectus*, and has features more advanced than *H. erectus* and more primitive than *H. neanderthalensis*.
- The European population of *H. heidelbergensis* are probably ancestors of *H. neanderthalensis*.
  The African *H. heidelbergensis* population is probably an ancestor of *H. sapiens*.

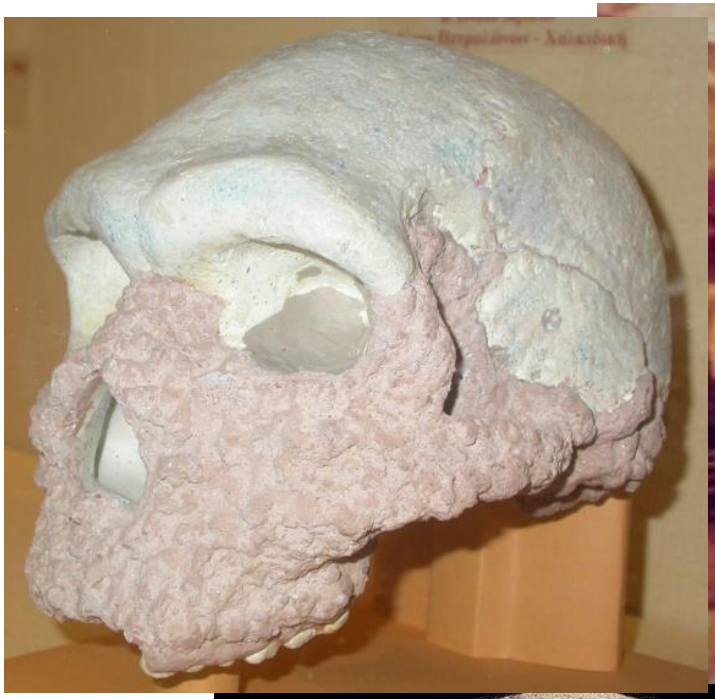


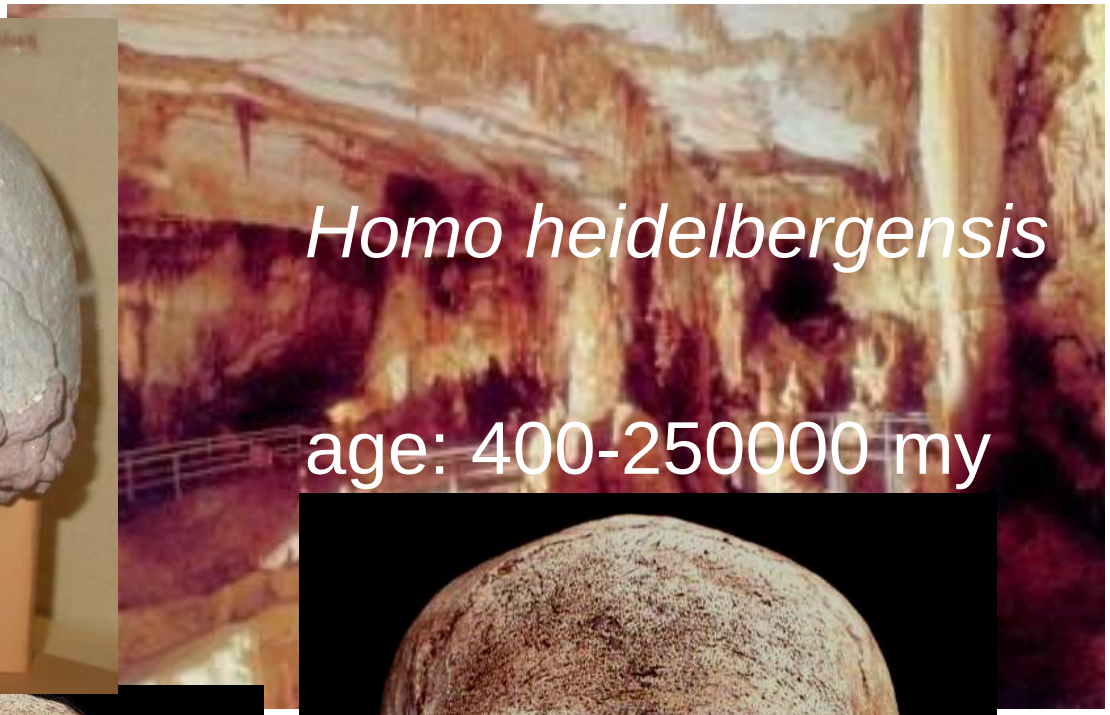




Petralona skull

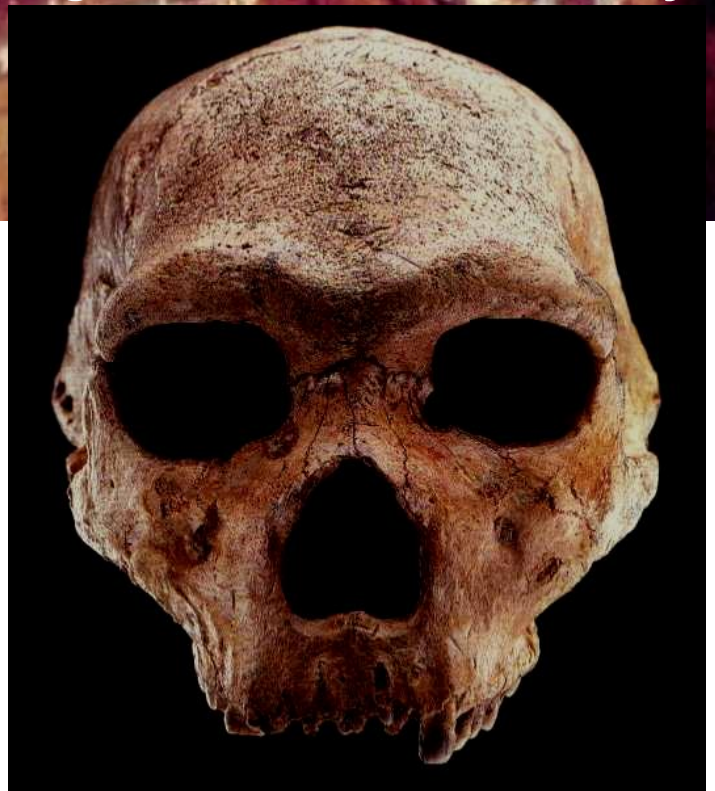
Petralona





Homo heidelbergensis

age: 400-250000 my



Apidima cave

H. neanderthalensis

- The humans of Upper Pleistocene are called Neanderthals or Neanderthal people.

- DNA analysis shows that it was a different species - *Homo neanderthalensis*. If this is the case, then it is a dead end clade of human evolution.

Homo neanderthalensis (left) and Homo erectus (right).

H. neanderthalensis

- Brain size equal to or greater than that of modern humans
- Over-sized superorbital arches
- Projected jaws but not as in *Homo erectus*.
- Not protruding chin - lower jaw not as bent as in *Homo erectus*
- Large nasal cavity (to heat cold inhaled air)


Homo neanderthalensis

Homo neanderthalensis (left),
and Homo sapiens (right).

Homo sapiens (left)

Homo neanderthalensis (middle)

Homo erectus (right).

H. neanderthalensis

- Neanderthals can be divided into three groups:
  The first Neanderthals lived about 250,000 to 130,000 years ago.
  Neanderthals existed during the transition to Upper Paleolithic about 130,000 to 45,000 years ago.
  The last Neanderthals lived from 45,000 to 28,000 years ago.

Neanderthals and sapiens

- In Central Europe, Neanderthals coexisted with modern people for thousands of years.
- Bones found in 2002, as well as recent DNA analyses (2009), have intermediate features between Neanderthals and modern humans, which is a matter of miscegenation.
- The Neanderthal skeletons were somewhat more robust than those of modern humans.
- Recent studies show that 1.8-2.6% of the non subsharian *H. sapiens* DNA is from Neanderthal

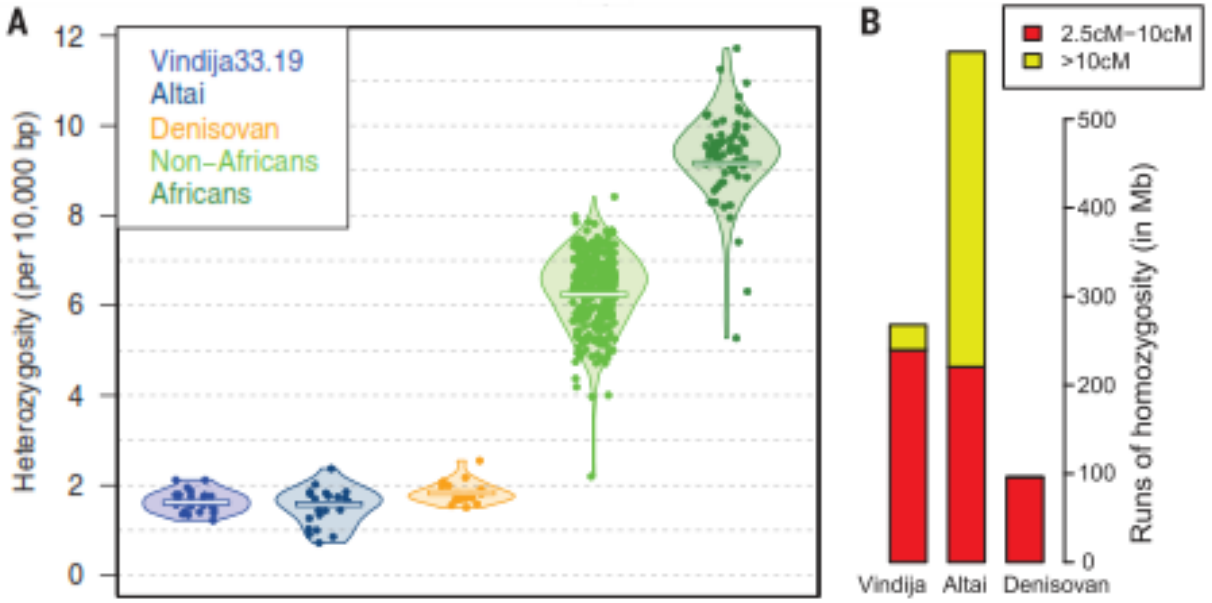
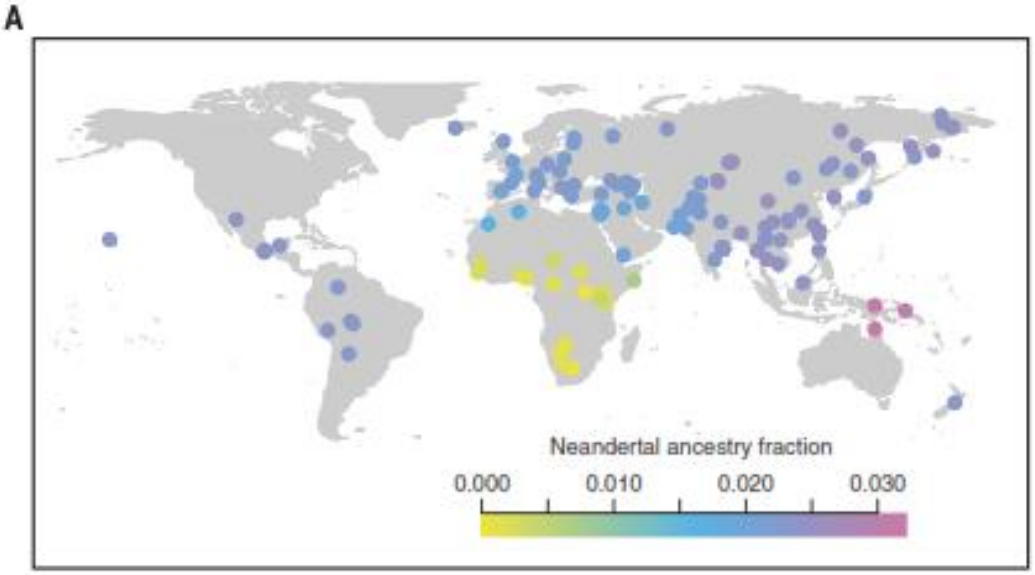


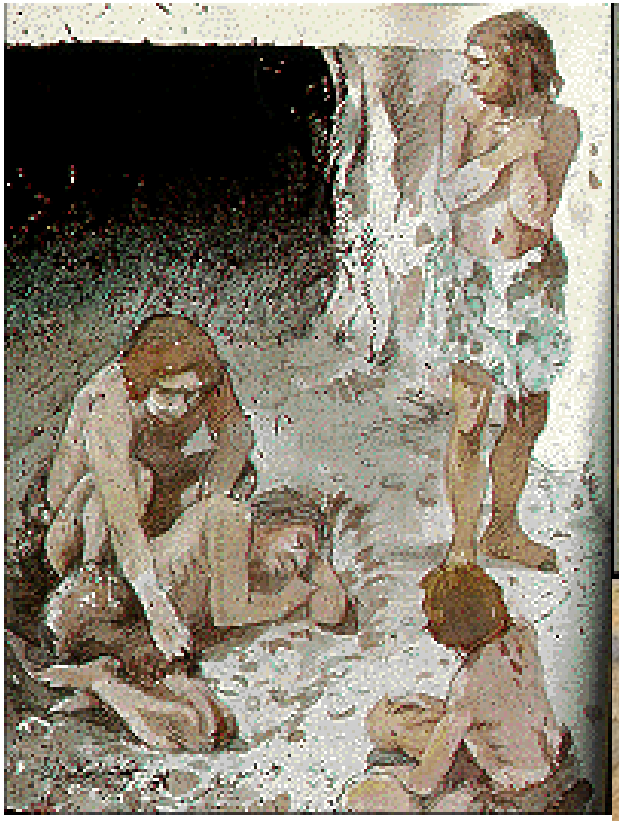
Fig. 1. Heterozygosity and inbreeding in the Vindija Neandertal. (**A**) Distribution of heterozygosity over all autosomes in the three archaic hominins, 12 non-Africans, and 3 Africans. Each dot represents the heterozygosity measured for one autosome. The center bar indicates the mean heterozygosity across the autosomal genome(s). (**B**) Genome covered by shorter (2.5 to 10 cM, red) and longer (>10 cM, yellow) runs of homozygosity in the three archaic hominins.

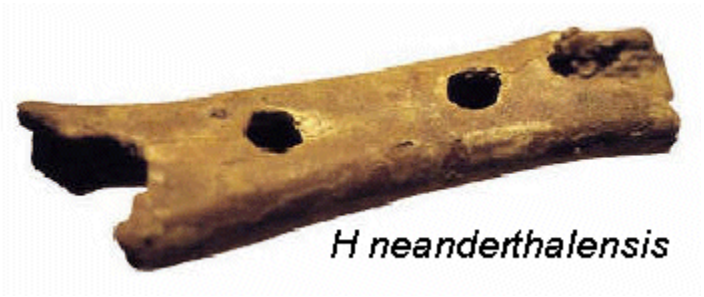


Prüfer et al., 5 October 2017

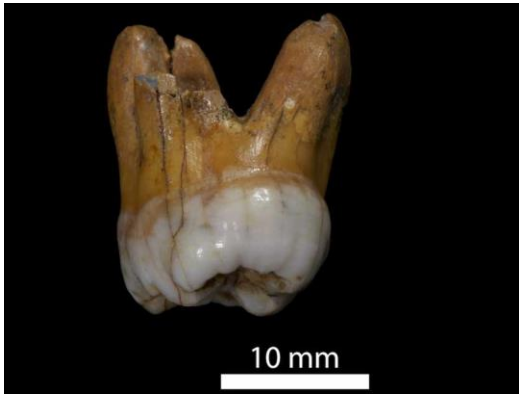
H. neanderthalensis

- Neanderthals hunted warm-blooded animals, such as bears, mammoths, hairy rhinoceros, reindeer, bison, etc.
- They built a wide variety of stone tools.
- They used fire to have light in the caves, heating, cooking and protection from the predators.
- They built dwellings of skins, wood and bone
- They gave interest in patients.
- They buried the dead along with gifts, showing that they believed in the afterlife.
- They used musical instruments, such as a flute made of bone, dated from 82,000 to 43,000 years ago.

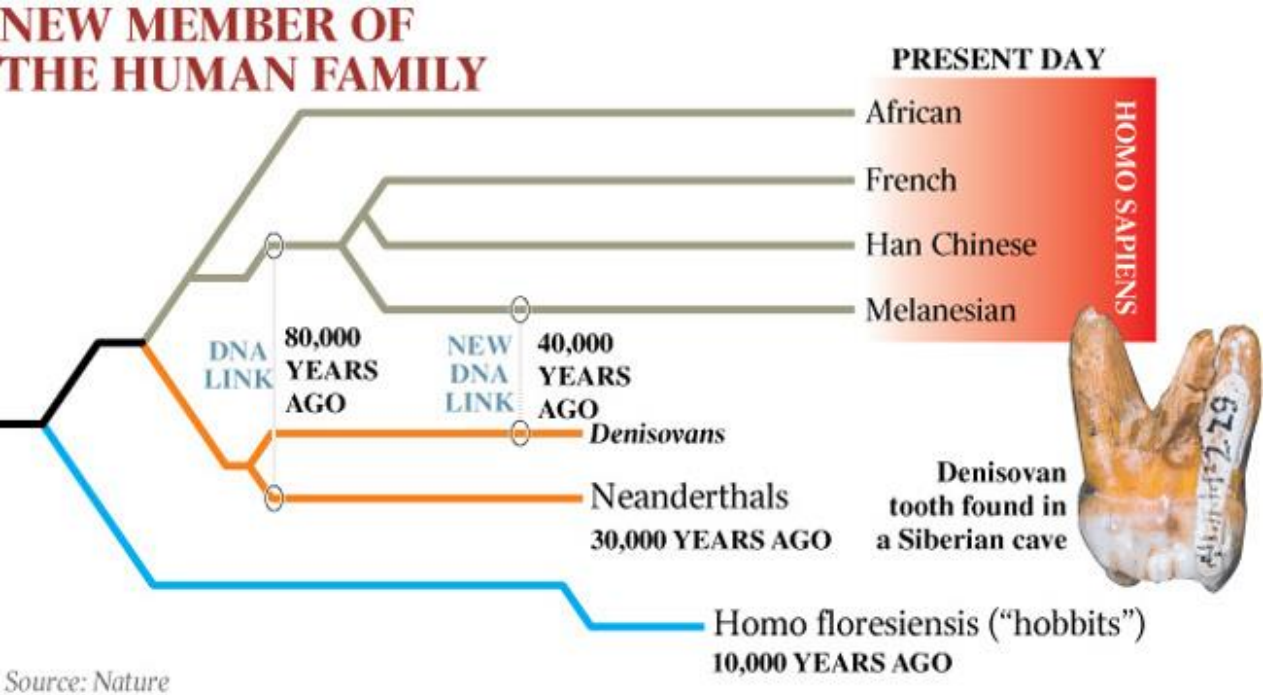



H neanderthalensis

Denisovans



In the Denisova Cave, in the Altai Mountains of Siberia, skeletal remains were found which differ from typical Neanderthals. DNA analyses confirmed this and showed that it is a sister taxon of direct affinity. Their genetic material has been identified in modern Asian populations.



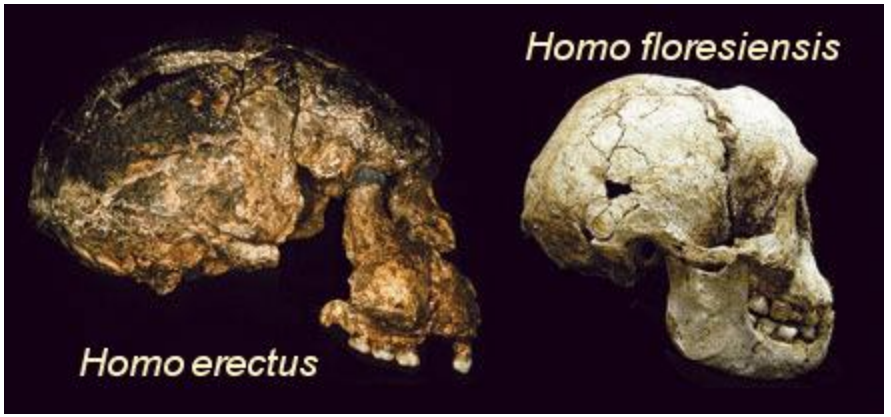
The “Hobits”

- In 2004, a new species of humans was discovered on the island of Flores, Indonesia, *Homo floresiensis.*
- 7 small skeletons were discovered in an excavation.
- Adults only 1 meter tall.

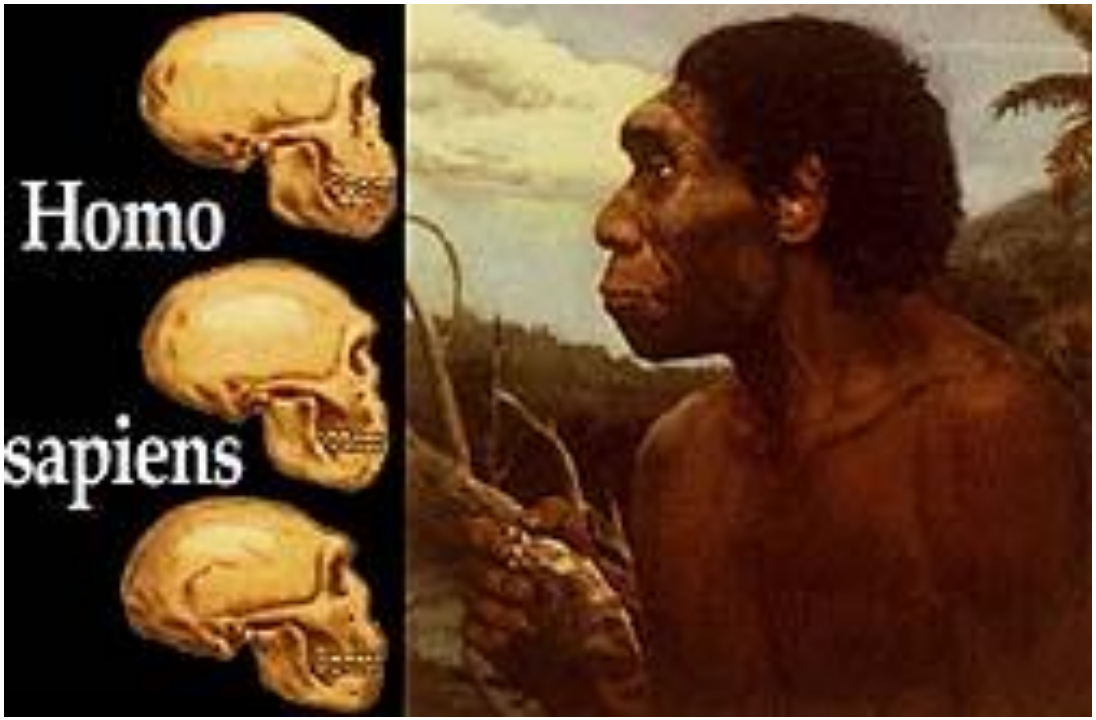
The “Hobits”

- *Homo floresiensis* lived about 13,000 years ago, at the same time as Neanderthals and modern humans.
- They hunted, used fire and made stone tools.
- The origin of the species is uncertain, although it is believed that *Homo erectus* probably arrived on the island about 800,000 years ago and differentiated into a small species due to insular living with limited food but with few predators.


Homo floresiensis


Homo floresiensis
Homo erectus

Homo sapiens



The first modern humans

- Fossils along the Omo River in South Ethiopia show that modern humans, Homo sapiens, lived in Africa some 195,000 years ago, according to a 2005 publication (McDougall et al., 2005).
- Before, they thought that modern humans appeared in Africa about 160,000 years ago.
- People have appeared in Africa for thousands of years before appearing on other continents.

New data June 2017

- New data this year from Jebel Irhoud in Morocco (Hublin et al, 2017) and based on the dates give an age for the first appearance of *H. sapiens* at 315 ± 34 thousand years (Richter et al., 2017)

Jebel Irhoud

The first modern humans

- There seems to be a time gap between the appearance of modern human skeletons and the modern way of behavior that led to the making of artifacts.
- Stone knife blades appeared 50,000 to 200,000 years ago.
- Other types of cultural elements, however, appeared only 50,000 years ago.

Out of Africa

- First exit from Africa to 120000 from findings in Palestine
- People have emigrated 70,000 years ago, and they seem to have taken along cultural elements like bone incises, stone tools, jewelry, artefacts and arrow heads.


Neanderthals
35,000 to
220,000 a
40,000 a
100,000 a
?
ORIGIN
200,000 a
ago
40,000 a
Florisbad
265,000 a
100,000 a
60,000 a

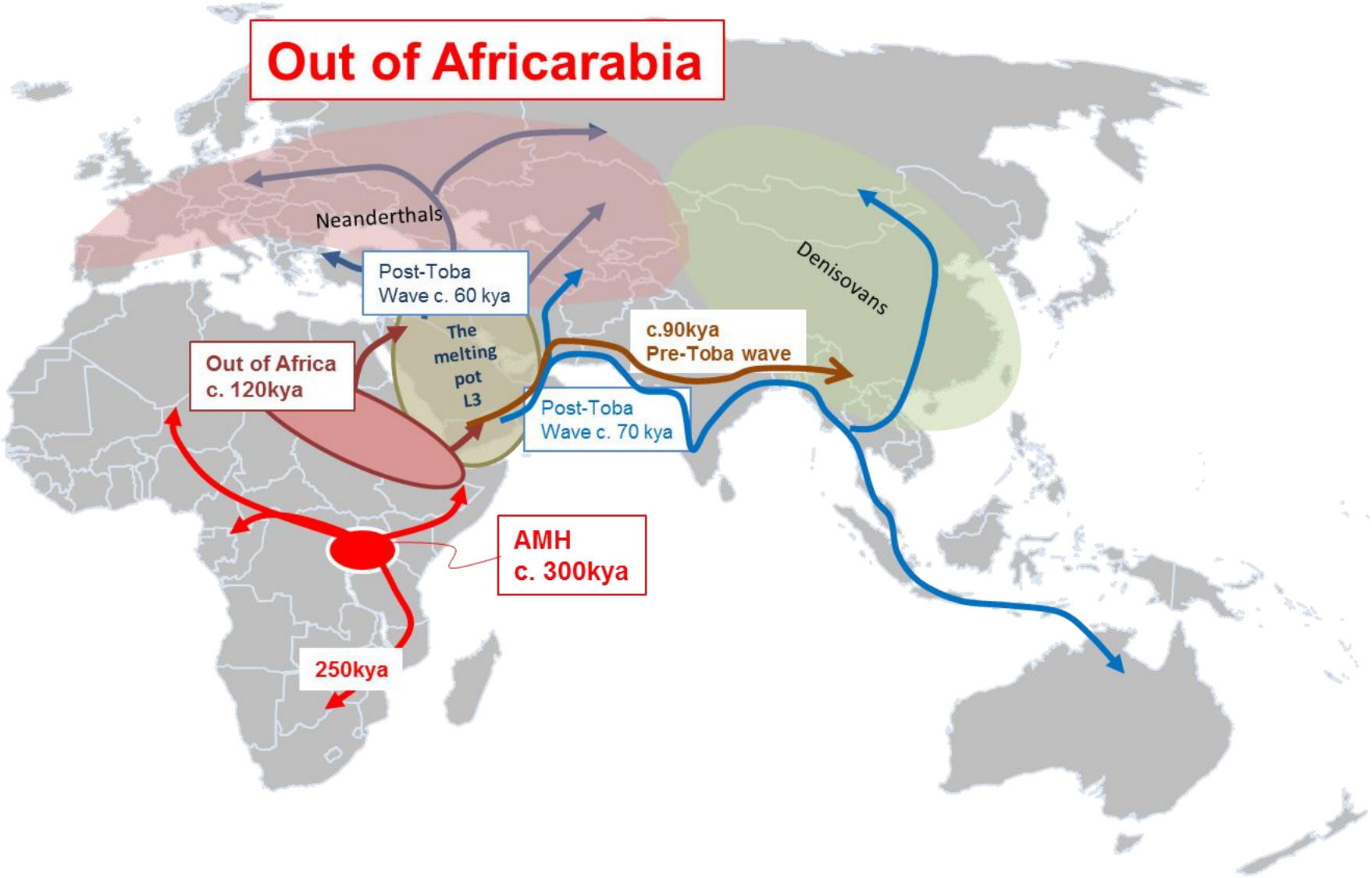
THE GREATEST WALK

The greatest human migration began 70,000 years ago in Africa.**A** With a mere eye-blink in evolutionary time, our ancestors had reached the last continental corner of the Earth—Tierra del Fuego, at the freezing tip of South America.**B** It was a journey of about 22,000 miles.

Theories about our species' routing out of Africa abound. Many scientists favor a route following the newly exposed seabeds near the Bab el-Mandeb Strait between Africa and Arabia. From there our ancestors spread into the Levant, Europe and Asia before finally reaching land's end in the Americas.

The reasons for this explosive diaspora of humans are complex - and the topic of much debate. Many scientists point to a drop in sea levels, creating land bridges for early wanderers to trudge across. This map uses sea floor elevation data to depict this drop in sea level.

MAP BY JEFF BLOSSOM, CENTER FOR GEOGRAPHIC ANALYSIS, HARVARD UNIVERSITY. DESCRIPTIVE TEXT BY PAUL SALOPEK. DATA SOURCES: ELEVATION - ESRI DATA AND MAPS ETOPO AND SRTM ELEVATION; IMAGERY - ESRI WORLD IMAGERY BASEMAP.

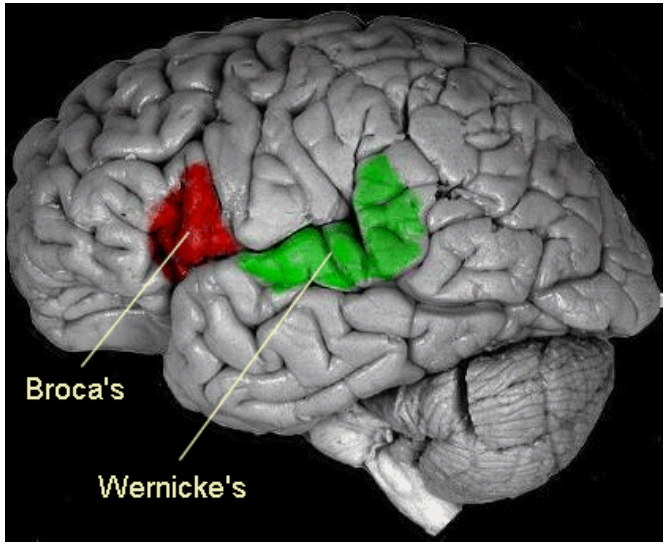

Out of Africarabia
Neanderthals
Post-Toba
Wave c. 60 kya
The
melting
pot
L3
Out of Africa
c. 120kya
c.90kya
Pre-Toba wave
Post-Toba
Wave c. 70 kya
Denisovans
AMH
c. 300kya
250kya

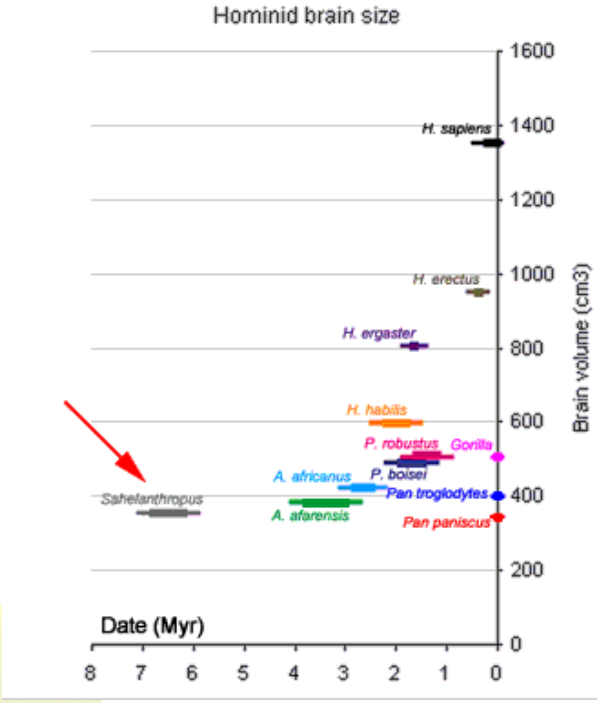
Cro-Magnon

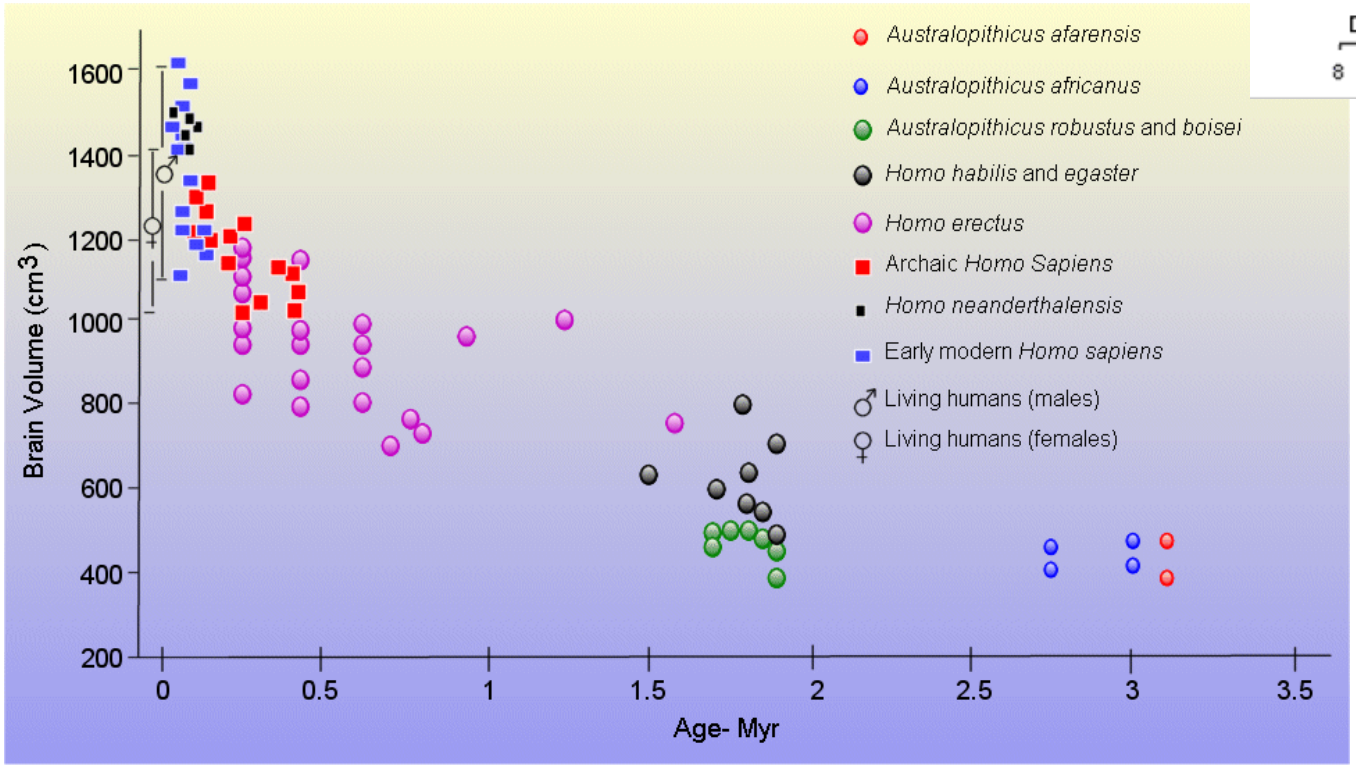
- About 34,000 years ago, during a glacial period, modern humans moved to the Neanderthal region and eventually replaced them. They were *Homo sapiens*, and they are called Cro-Magnon.
- The Cro-Magnon continued and further developed the Neanderthal cultural traditions:
  They built a larger variety of stone tools
  They painted animal images in caves
  They made sculptures of women and animals of bone or ivory
  They made and wore jewels
  They ritually buried the dead (they buried the hunters with their weapons)
  They held ceremonies and believed in the afterlife
  They were hunters and gatherers

Cro-Magnon

- Characteristics of Cro-Magnon:
- Taller than Neanderthals
- More vertical frontal bones
- protruding chins


Broca's
Wernicke's


Hominid brain size
Brain volume (cm3)
1600
1400
1200
1000
800
600
400
200
0
H. sapiens
H. erectus
H. ergaster
H. habilis
P. robustus
Gorilla
A. africanus
P. boisei
Pan troglodytes
Sahelanthropus
A. afarensis
Pan paniscus
Date (Myr)
8
7
6
5
4
3
2
1
0


Brain Volume (cm3)
1600
1400
1200
1000
800
600
400
200
0
0.5
1
1.5
2
2.5
3
3.5
Age- Myr
Australopithicus afarensis
Australopithicus africanus
Australopithicus robustus and boisei
Homo habilis and egaster
Homo erectus
Archaic Homo Sapiens
Homo neanderthalensis
Early modern Homo sapiens
Living humans (males)
Living humans (females)