U3A

Contributions to Geology

Lecture 2 The Palaeontologists

Introduction

- Palaeontology is the scientific study of past life forms
- includes the study of body fossil remains and evidence of their activities (trace fossils e.g. burrows, tracks, faeces)
- early scientists (Da Vinci, Hooke) interpreted fossils as remains of once-living organisms
- the science established during 18th century mainly through Georges Cuvier who developed studies of comparative anatomy and vertebrate palaeontology
- palaeontology developed rapidly during the 19th century

Georges (Baron) Cuvier (1769 - 1832)

French anatomist and palaeontologist, considered the "Father of Palaeontology"

- Expanded field of comparative anatomy into palaeontology
- somehow avoided losing his head during French revolution
- thrived under patronage of Napoleon

Georges Cuvier

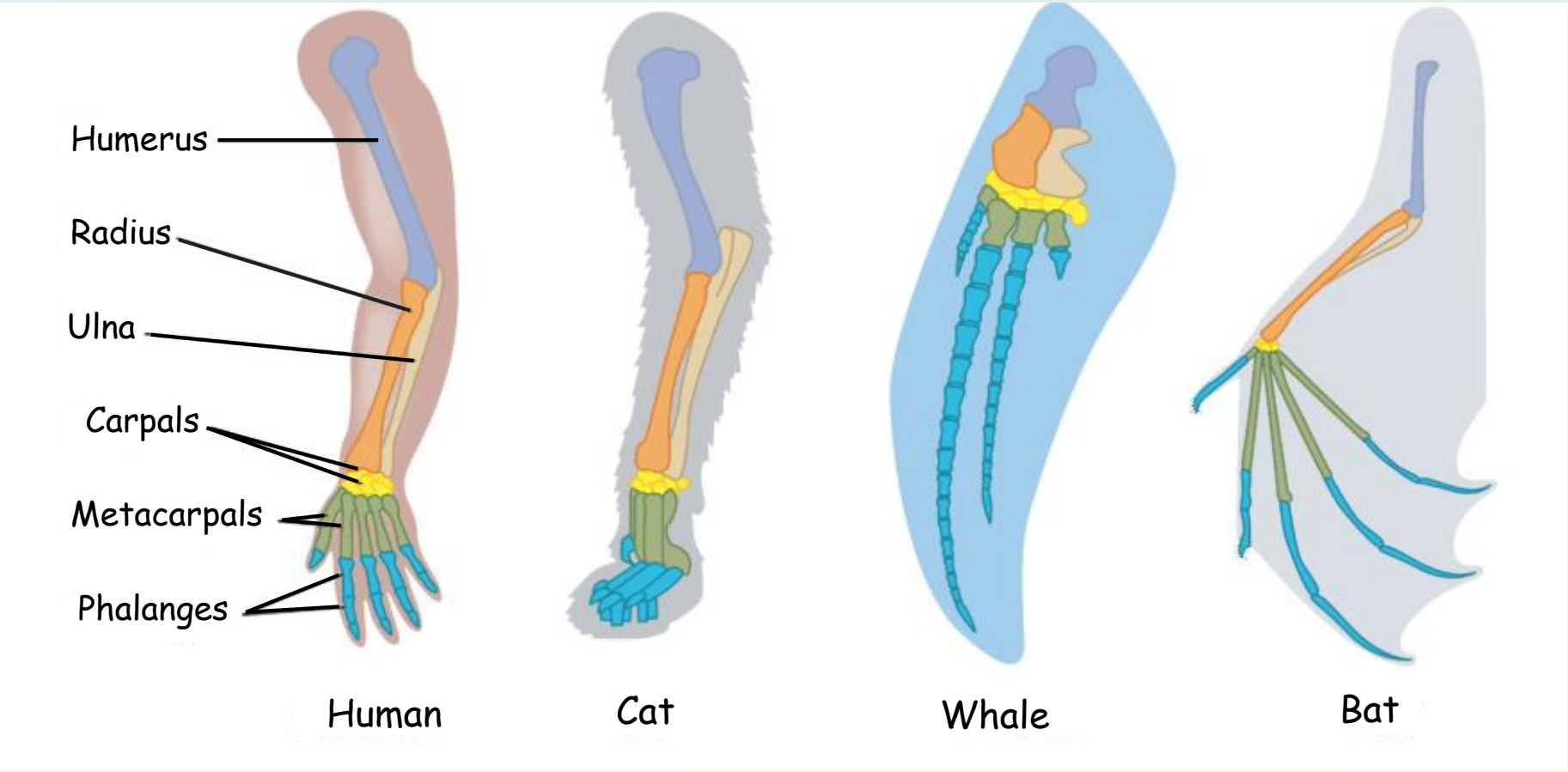
- Considered one of the greatest minds in the history of science
- born in Wurtemburg (then under French control)
- studied at Carolinian Institute in Stuttgart
- began his working life as a tutor in Caen and studied marine life
- published his first paper on molluscs along the Normandy coast
- in 1795 → appointed a professor of anatomy at Museum of Natural History in Paris
- instrumental in developing fields of comparative anatomy and vertebrate palaeontology

Georges Cuvier

- grouped classes of both fossils and living organisms into phyla with four branches (Vertebrata, Articulata, Mollusca and Radiata)
- believed similarities between organisms was ancestral → not due to function (opposed to Lamarck and other French naturalists)
- established the extinction of past life forms
- strong proponent of catastrophism (but not a young Earth)
- famous for his ability to reconstruct organisms from fossil remains
- one of first people to suggest that the Earth was dominated by reptiles and not mammals in prehistoric times
- prolific publisher of scientific papers and books on palaeontology

Comparative anatomy

- Study of similarities and differences in anatomy of different species
- used to provide evidence for evolution → indicating a common ancestor



Megatherium (Pliocene – Pleistocene)

- Cuvier reconstructed a skeleton of *Megatherium* from fossil remains → identified animal as a giant ground sloth endemic to South America
- lived from Lower Pliocene into the Holocene (5Mya to 4,500 years ago)
- Cuvier initially thought that the large claws were for climbing but later concluded that they were used for digging
- his ability to accurately reconstruct organisms was due to his vast knowledge of comparative anatomy

Megatherium (Pliocene – Pleistocene)

6 meters long weighed 4 tonnes

Artist impression of Megatherium

Megatherium (Giant ground sloth)

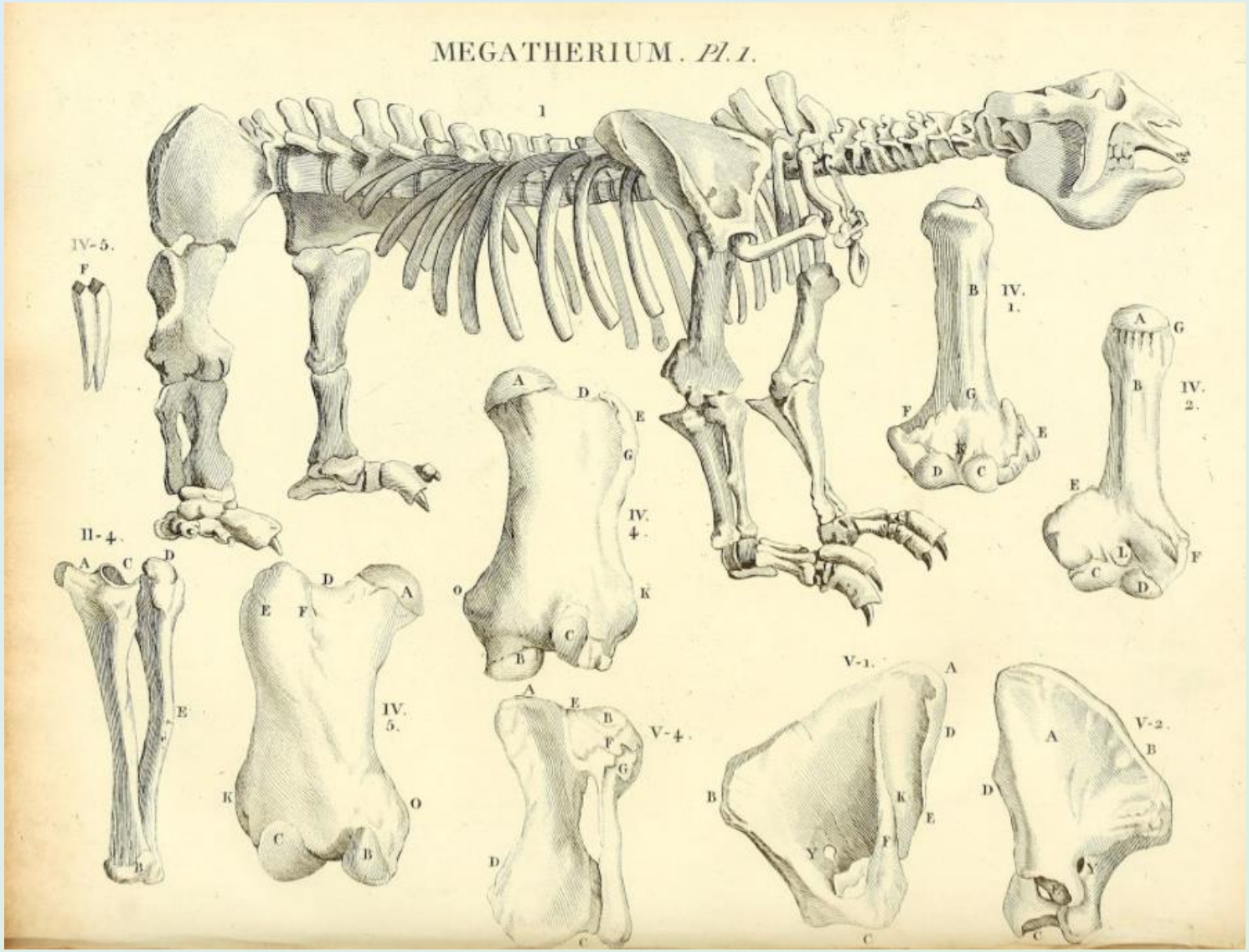


Illustration of Cuvier's reconstruction of *Megatherium*

Mary Anning (1799-1847)

She sells seashells on the seashore

The shells she sells are seashells, I'm sure

So if she sells seashells on the seashore

Then I'm sure she sells seashore shells.

Mary Anning

- Born in Lyme Regis on the Dorset coast
- began collecting fossils along Lyme Regis coast in her early teens
- large numbers of marine fossils → exposed during winter landslides
- sold fossils (mainly ammonites and belemnites) to support her family
- her discoveries include the first complete *ichthyosaur* skeleton, two *plesiosaurs* and the first *pterosaur* found outside of Germany
- Mary's discoveries became key evidence for extinction
- read scientific literature and studied anatomy through dissections of modern marine animals

Mary Anning

- internationally famous → constantly sought out by palaeontologists and fossil collectors
- marginalised by the "gentlemen geologists" (?) → trivialised her contributions → barred her membership to Geological Society of London
- after obtaining fossils from her → many refused to acknowledge her contributions in publications
- since her death → a number of extinct species are named after her
- in 2010 the Royal Society named her among the 10 British women that most influenced the history of science

Jurassic coast, Lyme Regis, Dorset

Ammonites

- Extinct class of cephalopods related to squids (Devonian-Cretaceous)
- fossils take form of planispirals → mm up to 2m in diameter
- excellent index fossils (large number of genera, extremely abundant)

Illustration of ammonite

Ammonite fossils in limestone, Lyme Regis

Belemnites

- Squid-like marine animals that lived during the Mesozoic Era
- possessed hard internal skeletons including a bullet-shaped rostrum
- ink sacs containing fossil ink are preserved in some fossils

Illustration of Belemnites

Fossilised Belemnite rostrums

Mary Anning – Plesiosaur fossil

- Carnivorous, marine reptiles that lived in the Mesozoic Era
- Plesiosaurs → broad flat bodies, relatively short tails, length up to 15m
- more than 100 species recognised → worldwide distribution
- two morphological types:
  - (1) short neck and large head
  - (2) long neck and small head

Plesiosaur (artist impression)

Mary Anning's Plesiosaur fossil

Mary Anning - *Pterosaur*

- Flying reptiles that lived in the Mesozoic Era
- wings formed from a membrane of skin, wing spans 25cm-11metres
- early species → long, fully toothed jaws and long tails

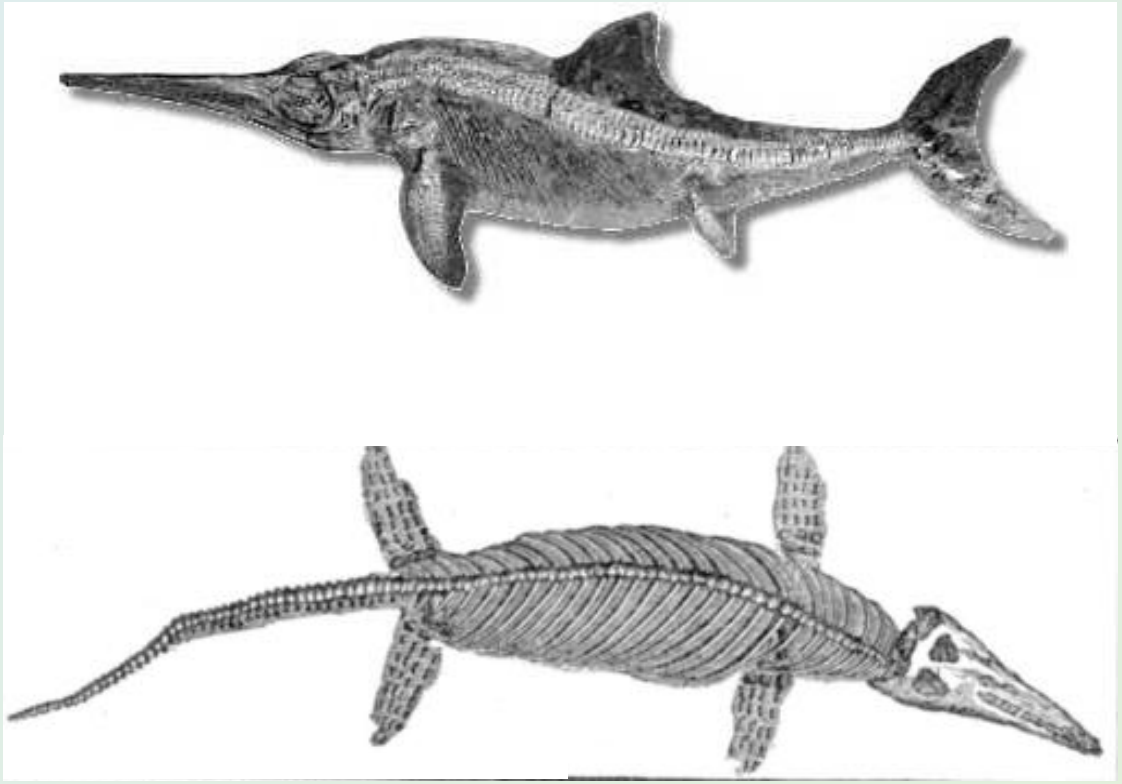
  later forms → reduced tails, some lacked teeth

Mary Anning's *Pterosaur* fossil find

Artist impression of *Pterosaur*

Mary Anning - *Ichthyosaur*

- Large marine reptiles of the Mesozoic Era
- superficially resembled dolphins
- 1-16metres in length, pointed heads, jaws with conical teeth, short necks, vertical tail fins, large eyes



Name plate on the site of the home of Mary Anning, Lyme Regis

Gideon Mantell (1790 – 1852)

English obstetrician, geologist and palaeontologist and good friend of Mary Anning was born in Lewes, Sussex

Gideon Mantell

- Interested in geology as a youth → keen fossil collector
- taught himself anatomy at young age
- studied medicine → received diploma from Royal College of Surgeons in 1811
- while practising medicine → spent every spare moment studying geology
- inspired by Mary Anning → developed an interest in marine fossils from Cretaceous chalk
- published several book on palaeontology including "The fossils of South Downs" in 1822

Gideon Mantell

- discovered the remains of many extinct animals
- discovered fossil remains of the first *iguanodon* and proved that it was not a mammal (as suggested by anatomist Richard Owen)
- discovered new genus of dinosaur called *Hylaeosaurus*
- became a bitter enemy of anatomist Richard Owen over plagiarism
- severely crippled in accident in 1841
- at time of death → discovered 4 of 5 genera of dinosaurs known
- biography contained in the book "The Dinosaur Hunters" (Deborah Cadbury)

Iguanodon

- Herbivorous, Ornithopod dinosaur that lived in the Mesozoic Era
- identified and named by Gideon Mantell
- one of three genera used to define the Group *Dinosauria*
- weighed ~3 tonnes, 10metres long
- teeth similar to an iguana, thumb spikes

Model of *Iguanodon*

Drawings of Mantell's *Iguanodon*

Tooth collection

Hylaeosaurus

- Herbivorous ankylosaurian dinosaur (Cretaceous) first described by Mantell in 1842
- about 5metres in long weighed about 2tonnes
- one of three animals used by Richard Owen to define the group *Dinosauria*

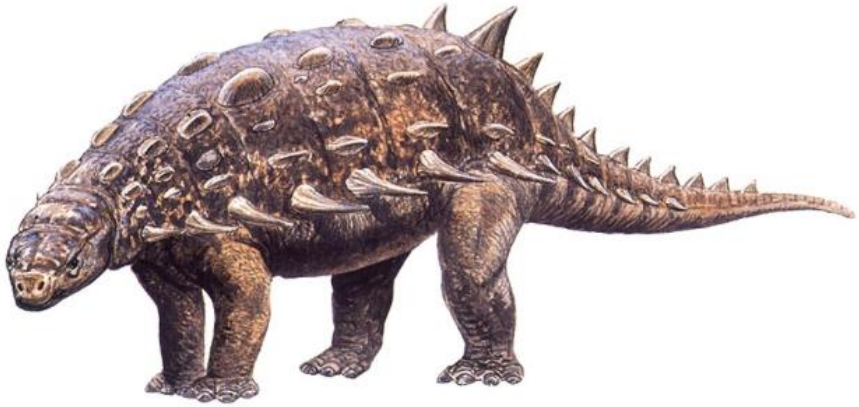
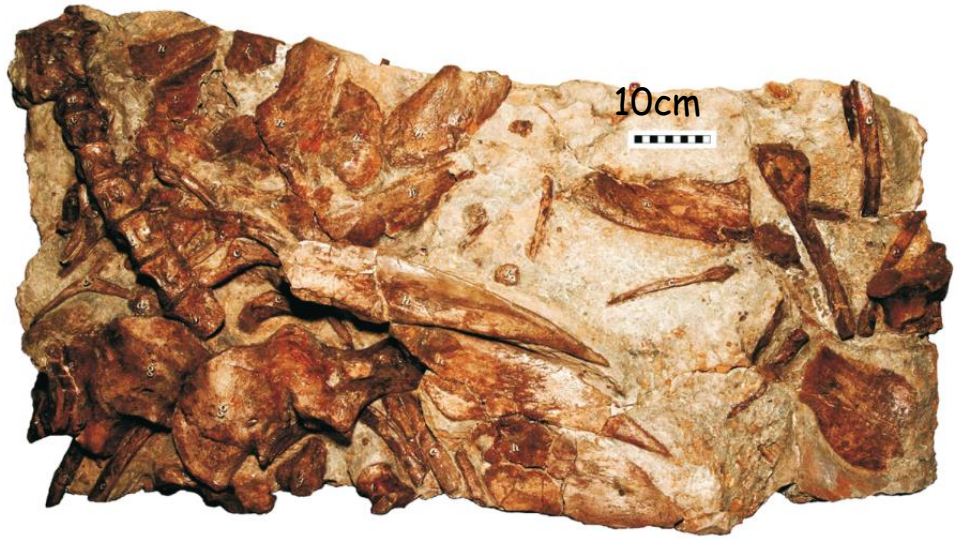
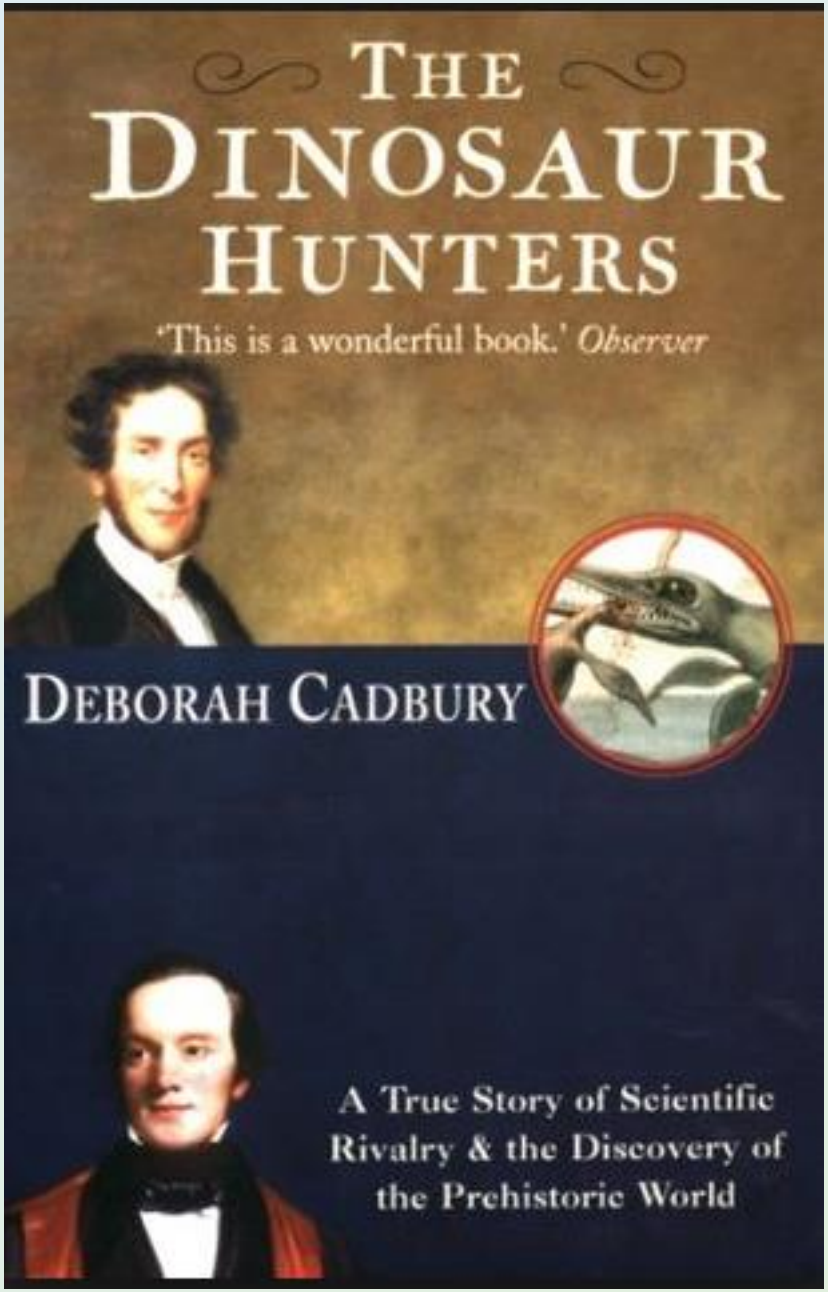


Illustration of Hylaeosaurus

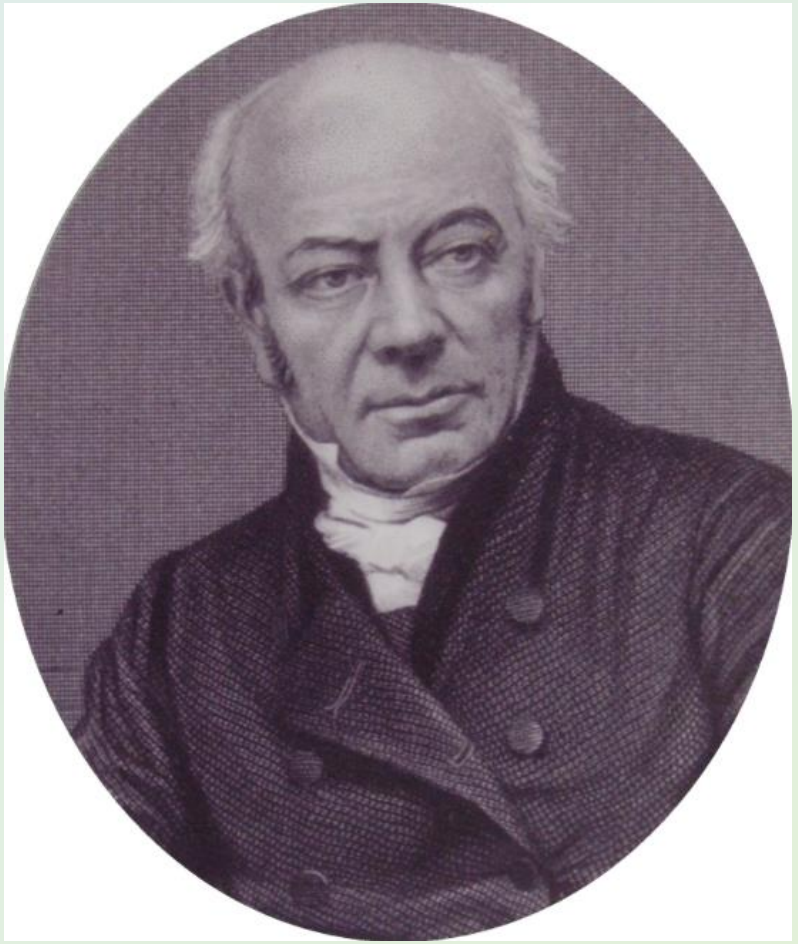


Hylaeosaurus fossil collected by Mantell


THE DINOSAUR HUNTERS
'This is a wonderful book.' Observer
DEBORAH CADBURY
A True Story of Scientific Rivalry & the Discovery of the Prehistoric World

Rev. William Buckland (1784-1856)

- English theologian, geologist and palaeontologist. Dean of Westminster
- studied for ministry at Corpus Christi, Oxford
- also attended lectures on mineralogy and chemistry
- ordained an Anglican priest in 1809
- first person to teach geology at an English University (Oxford 1813) giving lectures on mineralogy and palaeontology



William Buckland

- Famous for highly animated lectures and bizarre diet (he boasted of eating his way through the animal kingdom)
- did his fieldwork in academic garb, delivered lectures on horseback
- good humoured, good natured but not universally admired
- declared that the language of rocks was "as much a divine revelation as the bible"
- further asserted that "geology testified to God's design and that fossils illustrated the progress of life as it developed towards its divine destiny, that of man"
- challenged concept of a youthful Earth → proponent of GapTheory

William Buckland

- wrote a detailed account of giant reptile he called *Megalosaurus* (1824)
- first person to identify fossil faeces that he called coprolites
- discovered oldest modern human remains in Great Britain " Red Lady of Paviland" (dated 33,000years) in Paviland cave, Wales
- cast doubts on Noachian flood evidence → recognised glacial deposits
- non-elitist → encouraged and supported Mary Anning, Gideon Mantell and William Smith, supported his award of the Wollaston medal
- collaborated with numerous eminent geologists and palaeontologists
- set up Geological survey of Britain with Charles Lyell and Adam Sedgwick

Megalosaurus

- Large theropod that lived during the Middle Jurassic
- first non-avian dinosaur to be described and named
- large head with large curved teeth
- first thought to be quadrupedal → subsequently considered bipedal

Hip, femur and sacrum of *Megalosaurus bucklandii*

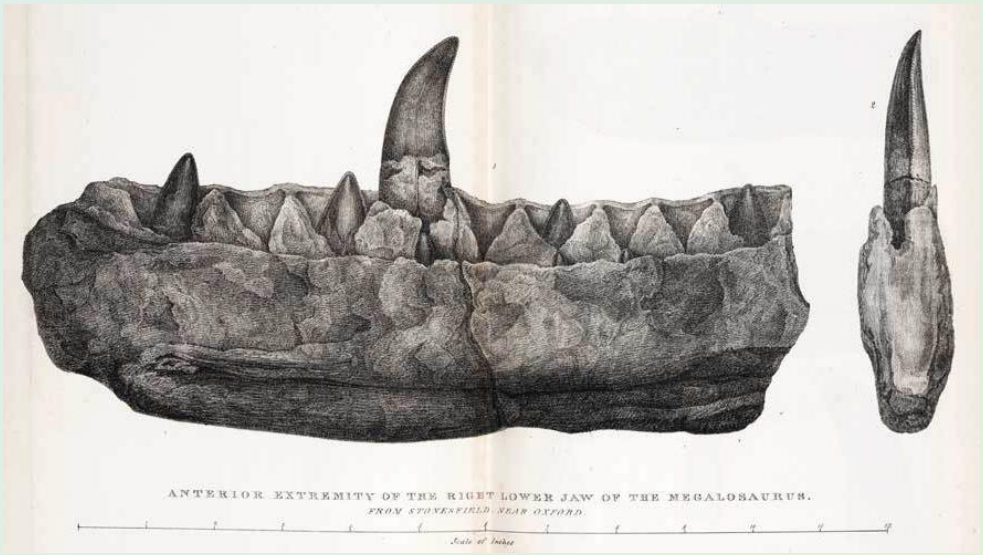


Illustration of lower jaw of *Megalosaurus*

Artist's impression of Megalosaurus

William Buckland's culinary delights

His boast of eating his way through the animal kingdom was legendary

Mice

Horse tongue

Hedgehog

Crocodile

Dog

Mole

Tortoise

Bluebottle fly

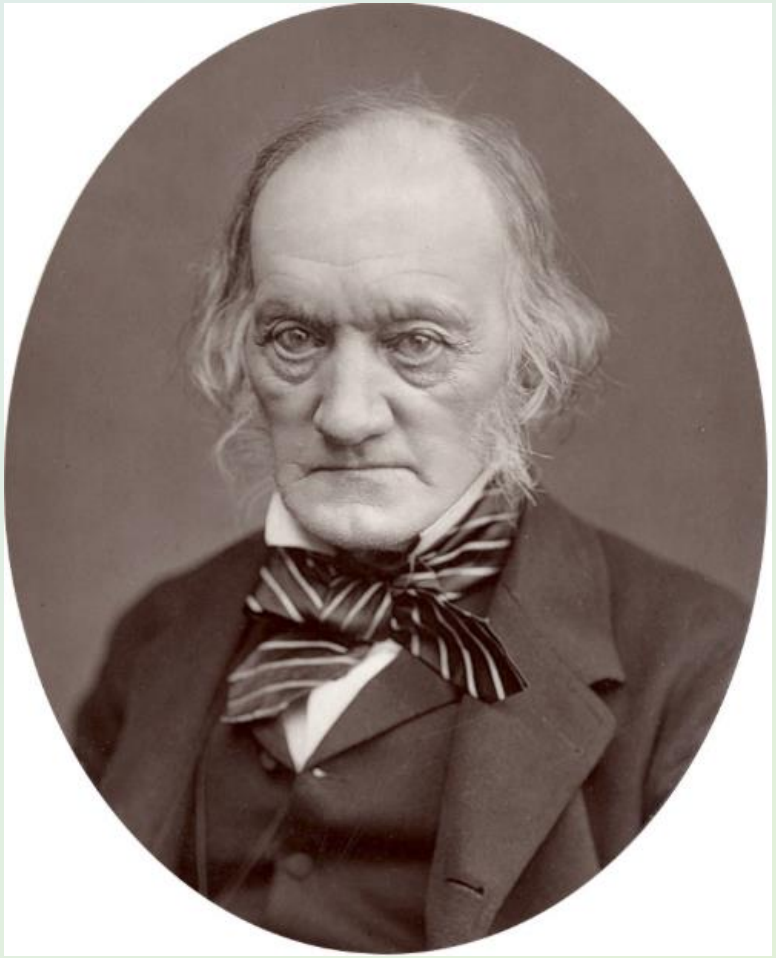
Panther

Ostrich

Preserved heart of King Louis XVI

Sir Richard Owen (1804 - 1892)

English biologist, anatomist and palaeontologist, outstanding naturalist at interpreting fossils. After Georges Cuvier, considered next greatest anatomist of 19th century



Sir Richard Owen

- Famous for coining the term Dinosauria
- undertook medical studies at Edinburgh University and St Bartholomews hospital London → acquired knowledge on comparative anatomy
- considered an outstanding naturalist in interpreting fossils
- named *Protichnites* → oldest fossil tracks found on land
- discovered and identified complex teeth structures of extinct animals he named *Labyrinthodontia*
- prolific contributor of scientific papers on brachiopods, molluscs, arthropods and vertebrates

Sir Richard Owen

- outspoken critic of Charles Darwin (and just about everyone else)
- universally disliked → vicious temperament, blatant plagiarist
- falsely claimed discovery of a belemnite species → voted off councils of Zoological and Royal Societies
- appointed superintendent of natural history dept. British Museum (1856)
- falsely credited himself and Cuvier with having discovered *Iguanadon*
- when Mantell was crippled, Owen renamed several dinosaurs already named by Mantell and then claimed credit for their discovery
- one of the most odious and unscrupulous men in the history of science

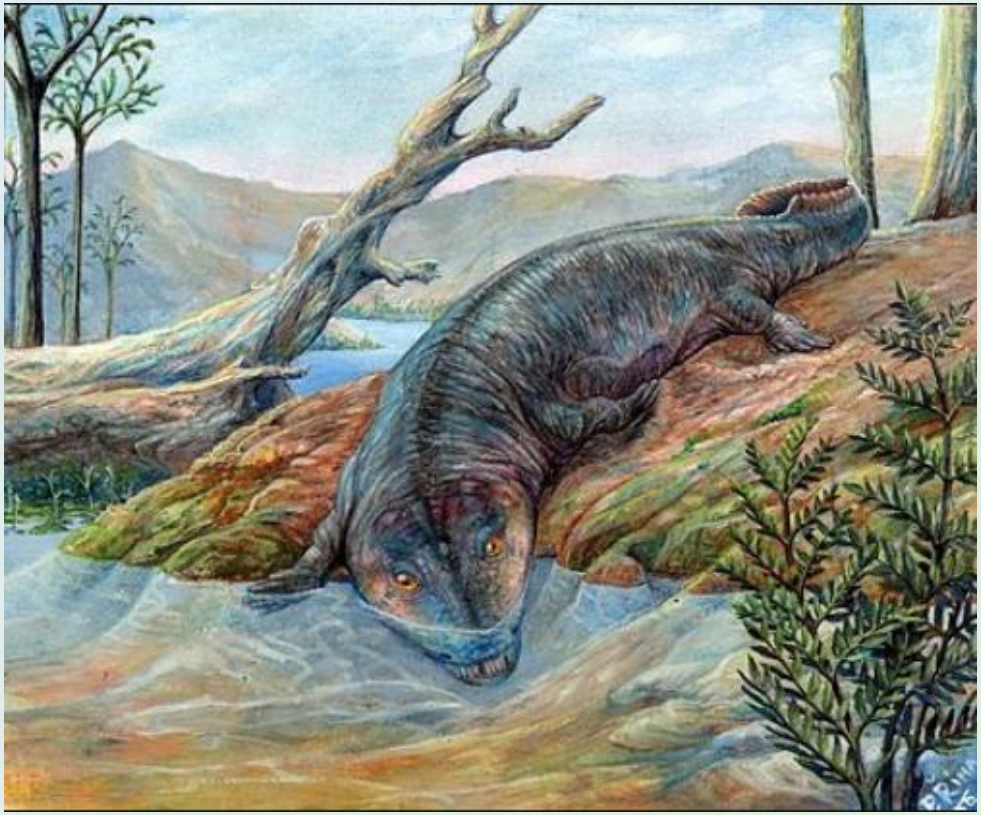
Protichnites

- *Protichnites* is a trace fossil consisting of two parallel tracks
- furrow between tracks → due to tail contacting substrate
- possible candidates → Horse shoe crabs, trilobites

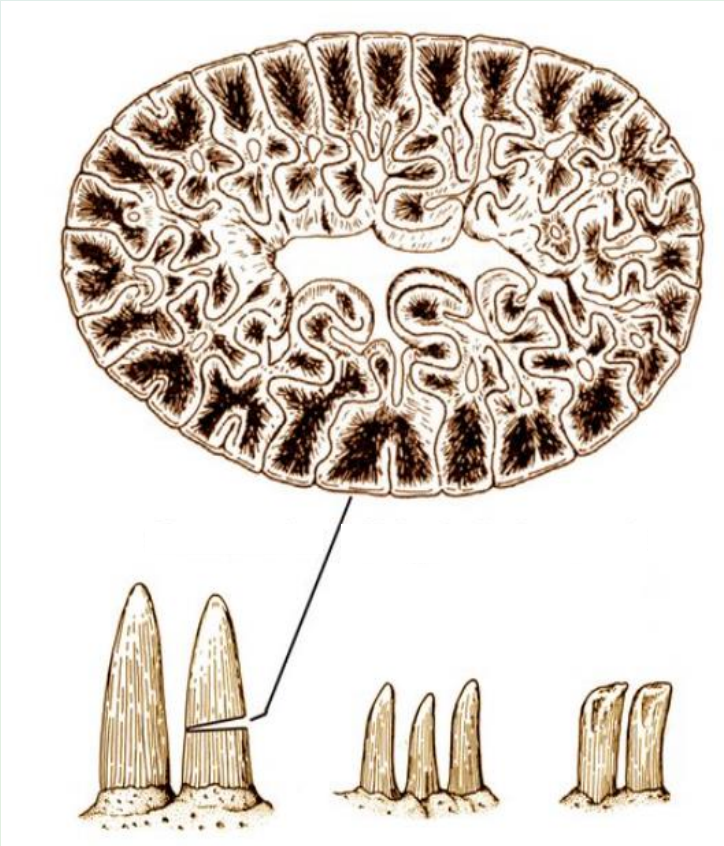
Protichnites of Potsdam Sandstone, Quebec, Canada

Labyrinthodontia

- Extinct amphibian of Late Palaeozoic and Mesozoic Eras
- name → complex folded dentin and enamel of teeth
- massive skull and complex vertebrae



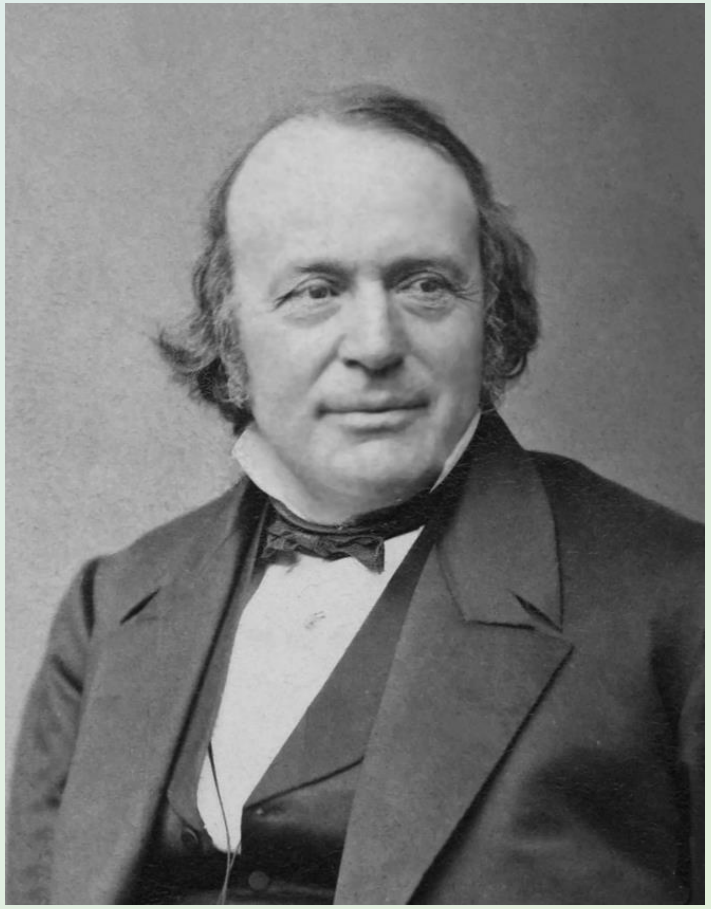
Artist impression of Labyrinthodont



Cross section of Labyrinthodont tooth

Louis Agassiz (1807 – 1873)

- Swiss/American physician, biologist and geologist → principally a biologist interested in fish fossils
- made outstanding contributions on natural history
- received PhD and medical degree at Erlangen and Munich respectively
- studied under Cuvier and von Humboldt
- referred to as "the father of glaciology"



Louis Agassiz

- from working in the Swiss Alps → concluded that historic glaciers were formerly more extensive → extended beyond current boundaries
- first person to recognise that the Earth had been subject to previous prolonged ice ages
- collaborated with William Buckland → described glacial features in the British Isles
- in 1840 published two volumes entitled "Etudes sur les glaciers"
- appointed professor of zoology and geology at Harvard in 1847
- made outstanding contributions to icthyological classification and the glacial geology of North America
- a creationist → wrote prolifically on controversial topic of polygenism

Illustration of fossil fish (extract from "Research on Fish" Louis Agassiz 5 volumes).

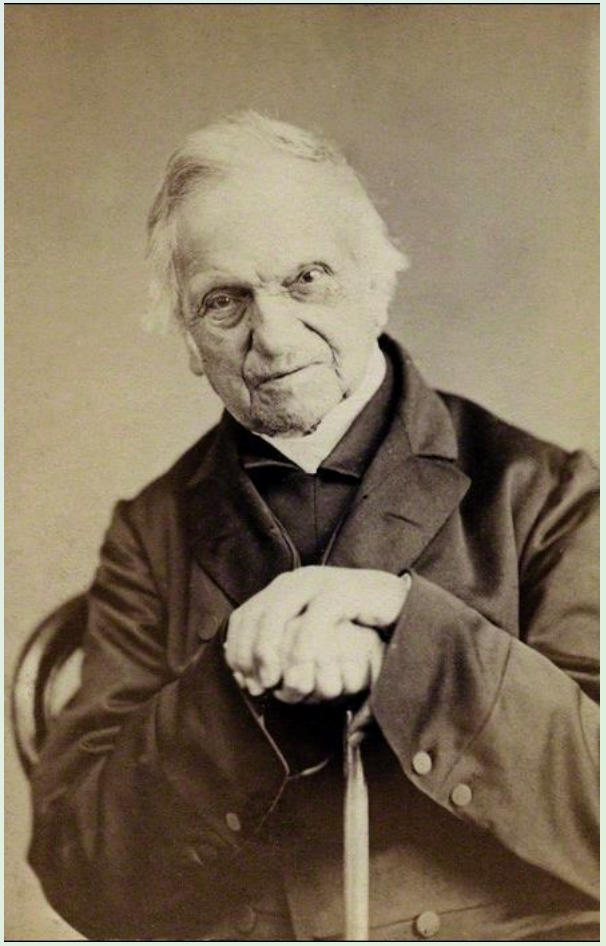
Agassiz and polygenism

- After Agassiz arrived in USA he wrote prolifically on polygenism
- Polygenism → races were created separately, could be classified on basis of specific climate zones and were endowed with unequal attributes (e.g. some races are more intelligent than others)
- these ideas are now considered as scientific racism
- he was a creationist and believed that nature had order because God created it that way
- a large number of landmarks that bore his name were subsequently changed after protests regarding his polygenism

Rev. Adam Sedgwick (1785 -1873)

Theologian, geologist, palaeontologist and academic

- Studied mathematics and theology at Trinity College Cambridge
- ordained a minister in 1818 and appointed Woodwardian professor of geology at Cambridge University



Adam Sedgwick

- Built up university mineral and fossil collection with help from Mary Anning
- first academic in England to open his classes to women
- his lectures were entertaining and he was much loved by his students
- mentor of Charles Darwin (and later critic) but remained a friend
- supporter of William Smith in gaining Wollaston Medal
- defined and named Devonian and Cambrian systems of the Palaeozoic
- embroiled in Cambrian-Silurian dispute with Roderick Impey Murchison

The Cambrian-Silurian controversy

- In 1834 Murchison identified older rock formations below Devonian rocks he named the Silurian system
- Sedgwick identified even older rocks below the Silurian he named Cambrian
- bitter dispute ensued → Murchison claimed the rocks were lower Silurian
- main issue involved overlapping of Upper Cambrian and Lower Silurian
- after both men were dead, Cambrian was accepted and another division (Ordovician) was given to the overlapping period of time