# The dinosaurs of Eastern Europe

Michael J. Benton (University of Bristol)

Bright Horizons 10

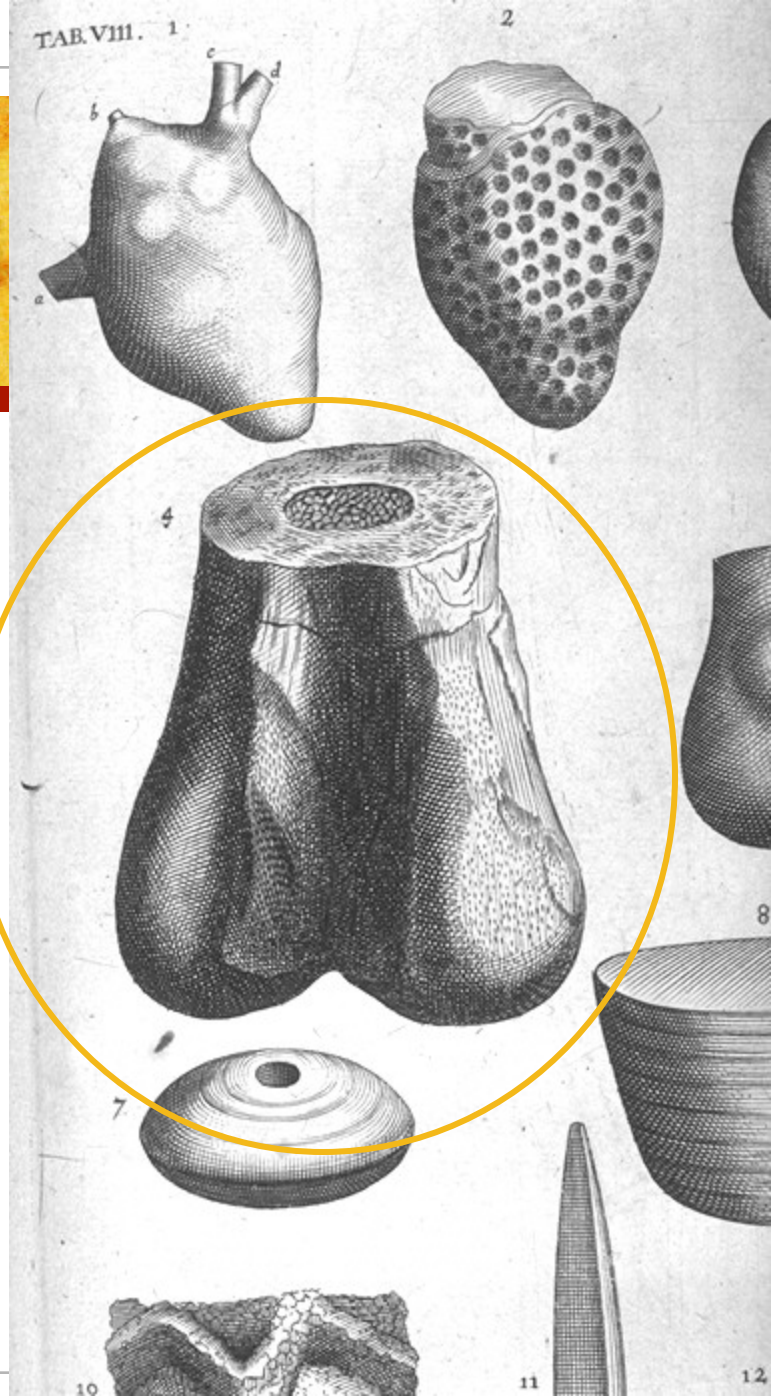
Thursday, October 6th, 2011

# Discovering dinosaurs

- Now, we know dinosaurs from every continent on Earth, including Antarctica, but that has not always been the case…
- Dinosaurs were first found close to where scientists lived – Europe and North America – and then further afield
- The dinosaurs from Eastern Europe are a surprising lot – many of them were dwarfs, and they were studied by some rum characters, including a man who failed in his efforts to become King of Albania, but spied for both sides in WW1
- Let's explore how palaeontologists put together their understanding of the diversity of dinosaurs worldwide… and explore what they tell us about ancient geography and island effects…

# *Scrotum*

- The first published record of a dinosaur bone was in Robert Plot's *Natural History of Oxfordshire* published in 1677
- He identified it as part of a thigh bone from just above the knee joint, and he thought it came from a giant man or woman
- Named *Scrotum humanum* by Brookes in 1763 - (un)fortunately determined as a *nomen oblitum* - otherwise the first formal dinosaur name



# Gideon Mantell

- Mantell (1790-1852) was a working country physician - struggled against prejudice from other palaeontologists who did not have to work for a living
- Named *Iguanodon* in 1825 and *Hylaeosaurus* in 1833

# Richard Owen

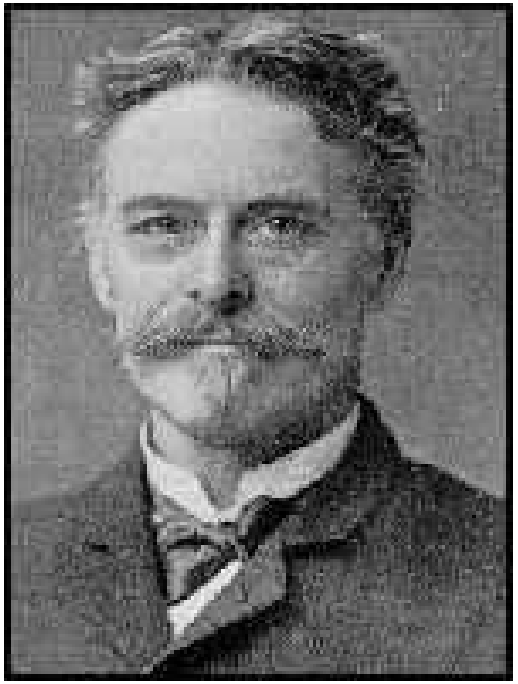
- Owen (1804-1892) had to work for a living, but based in London and established a strong position fast as Professor of Anatomy at Royal College of Surgeons in his 30s
- Tutor to Queen Victoria's children
- Brilliant anatomist
- Squabbled with Mantell
- Mantell's backbone (scoliosis)
- Owen curated his enemy's spine

# First dinosaurs from North America

- First finds were footprints from Triassic of New England, found in 1807 - identified as prints of giant birds by Edward Hitchcock
- Joseph Leidy (1823-1891) described isolated dinosaur teeth and bones from the Cretaceous of New Jersey in the 1850s, and then a complete hadrosaur skeleton in 1865

# The Bone Wars 1

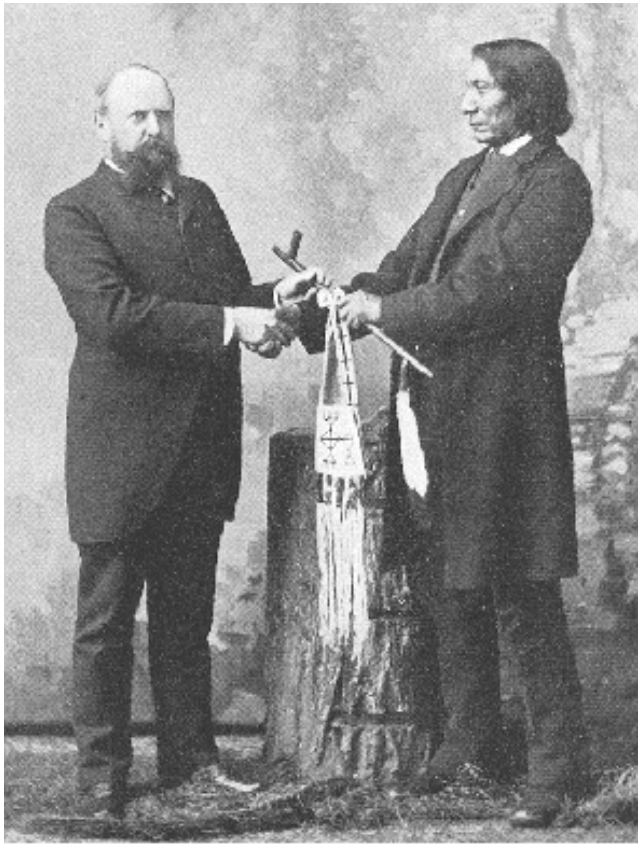
- Edward Drinker Cope (1840-1897)
- Wide-ranging zoologist and palaeontologist - worked on modern amphibians and reptiles, as well as fossil dinosaurs and mammals
- Named over 1000 new species in his lifetime
- Noted the propensity for species to increase in size through time - known as Cope's Rule



# The Bone Wars 2

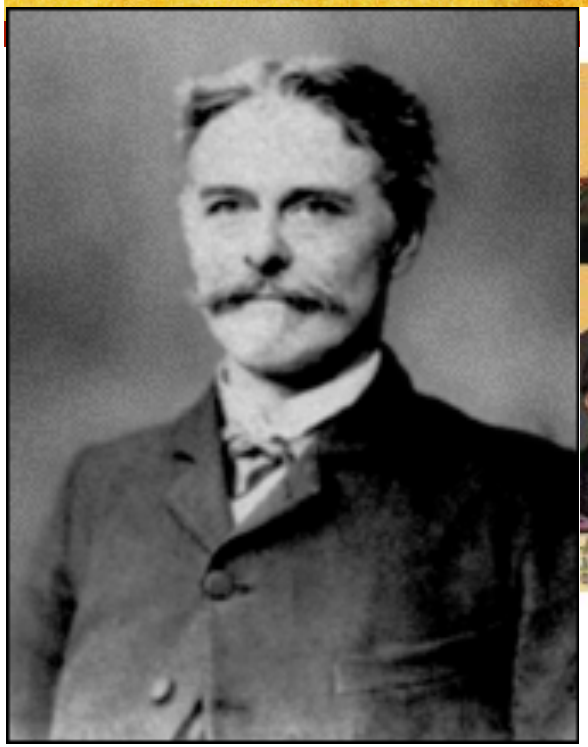
- Othniel Charles Marsh (1831-1899)
- Named many hundreds of dinosaurs, fossil birds and fossil mammals…

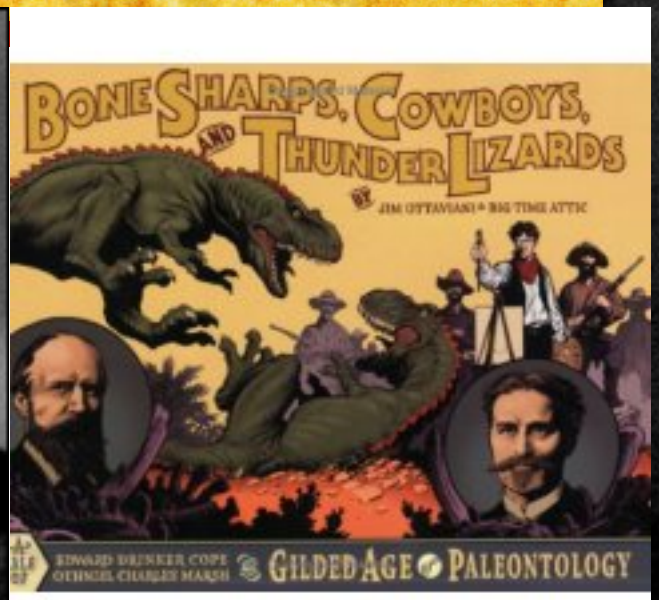
Marsh field crew - 1872

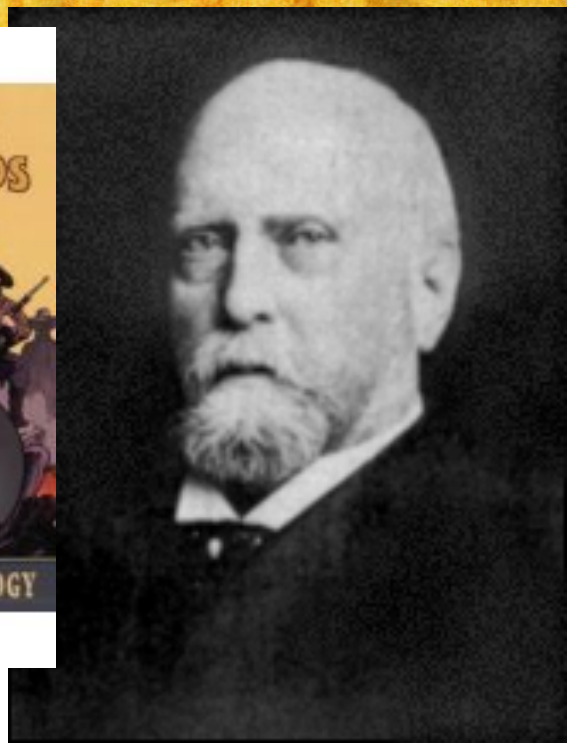


Marsh & Red Cloud
1883. New Haven, CT

# The Bone Wars 3





Cope Marsh

"There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."
- Mark Twain (1883) *Life on the Mississippi*

# Baron Franz von Nopcsa 1

- Franz Baron Nopcsa von Felsö-Szilvás (1877-1933) was born of a noble Hungarian family at Haţeg, then in Austro-Hungarian empire, now SW Romania
- Educated in geology at University of Vienna
- Spoke numerous languages, including Hungarian, German, Romanian, French, and English
- His sister found dinosaur bones on the family estate in 1895

# Baron Franz von Nopcsa 2

- Nopcsa family mansion at Szentpéterfalva – now a childrens' home
- Nopcsa showed the bones to Eduard Suess at the University of Vienna, and he encouraged the young man to study them
- So, in 1899, Nopcsa described the specimens in his first scientific paper

# Baron Franz von Nopcsa 3

- Nopcsa continued palaeontological studies at the same time as intriguing politically
- He published many highly innovative papers in leading European journals up the 1930, in German, English and Hungarian
- Meanwhile he spied for England and or the Austro-Hungarians during WWI
- Later, he sought to be king of Albania
- Toured Europe in a motorcycle combination with his ‘secretary’ and committed suicide in 1933

# Baron Franz von Nopcsa 4

Nopcsa's main scientific contributions:

1. **Systematic palaeontology**. Nopcsa described nine species of dinosaurs and other fossil reptiles, of which six are still regarded as valid taxa.

2. **Chronostratigraphy and mapping**. Nopcsa dated the Haţeg deposits as terminal Cretaceous, and he produced the first detailed geological map of the region.

3. **Evolution**. Nopcsa recognized that most of the Haţeg taxa were primitive, and they showed, he felt, most similarity with Late Jurassic and Early Cretaceous forms from elsewhere.

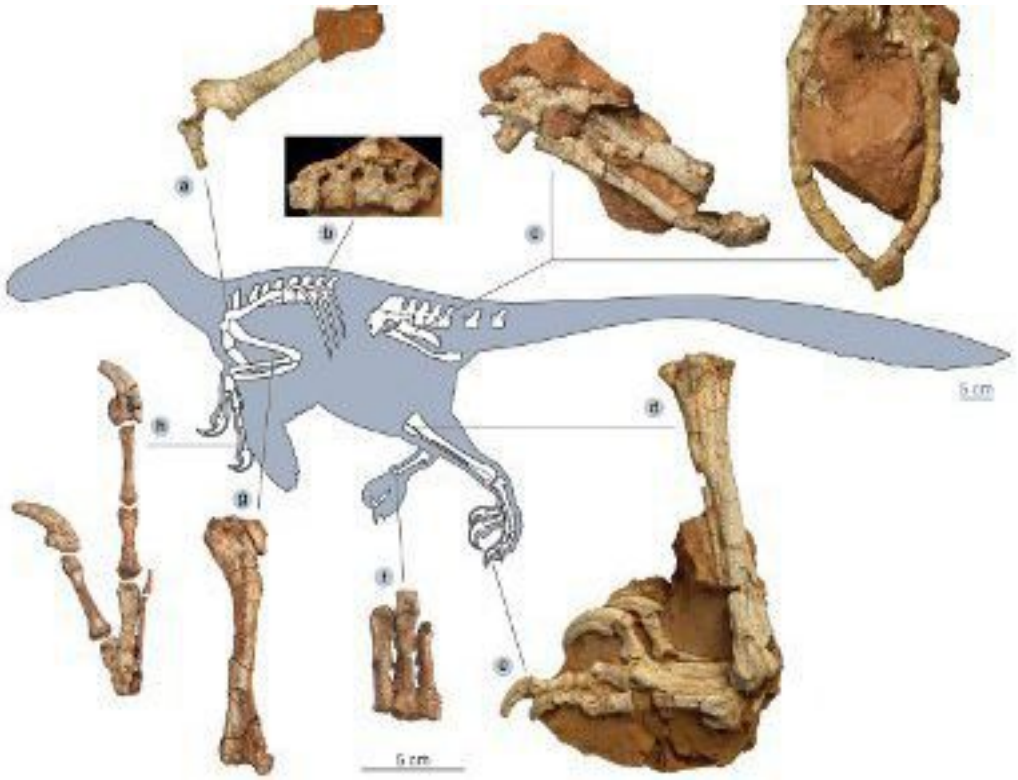
4. **Palaeobiology**. Nopcsa interpreted the apparently primitive nature of the Haţeg reptiles as a result of isolation on an island. He also noted that most of the Haţeg species were smaller than their relatives elsewhere, and he attributed this to the phenomenon of 'island dwarfing'. [Sexual dimorphism; origin of flight; taphonomy]

# Eastern Europe

- Location of Haţeg in SW Romania – close to modern borders of Hungary, Serbia, and Bulgaria
- Broad area called Transylvania- famous for stories of Count Dracula and Vlad the Impaler
- Few dinosaurs from Poland, Czech and Serb areas… a spectacular recent find in Romania…

# *Balaur bondoc*

- New dromaeosaurid theropod named in 2010
- Size of a turkey, but powerful slashing claws on hands and feet
- Shows there are still new dinosaurs to be found, even in Europe



# Romania today

- Little work was done on the Romanian dinosaurs during the post-war time of communism, culminating in the rule of Nicolae Ceaucescu

# Haţeg 1

- Nopcsa found his dinosaur bones in the 1890s around the Haţeg area in SW Romania
- Beautiful Carpathian Mountain scenery
- Extensive exposure of bedded Upper Cretaceous river deposits
- Now a Geopark, recognised by UNESCO for the international importance of the dinosaur finds

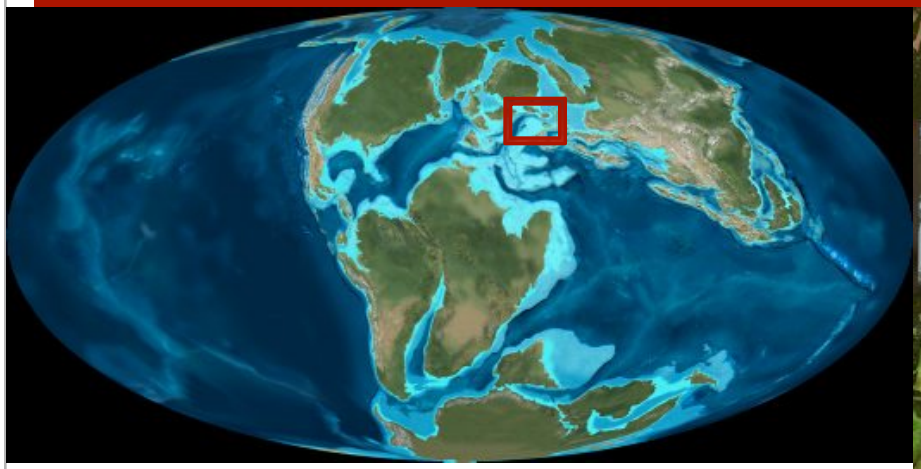
# Haţeg 2

- Repeat field trips to Haţeg by international research teams since 1990 – dinosaur bones very well preserved

# Haţeg 3

- We concentrate here on the dinosaurs, but there have also been many smaller fossils reported, including turtles, crocodiles, birds, pterosaurs, and mammals
- Small bones are found by sieving tonnes of sediment

# Haţeg 4

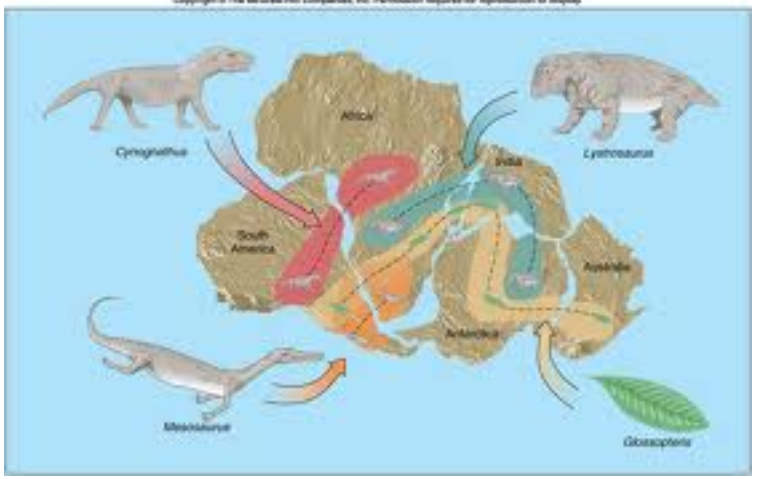


- Sediments and plants show that the area was lush and full of life
- River-deposited sediments full of fossils
- Warm, humid, semi-tropical climate

# Continental drift 1

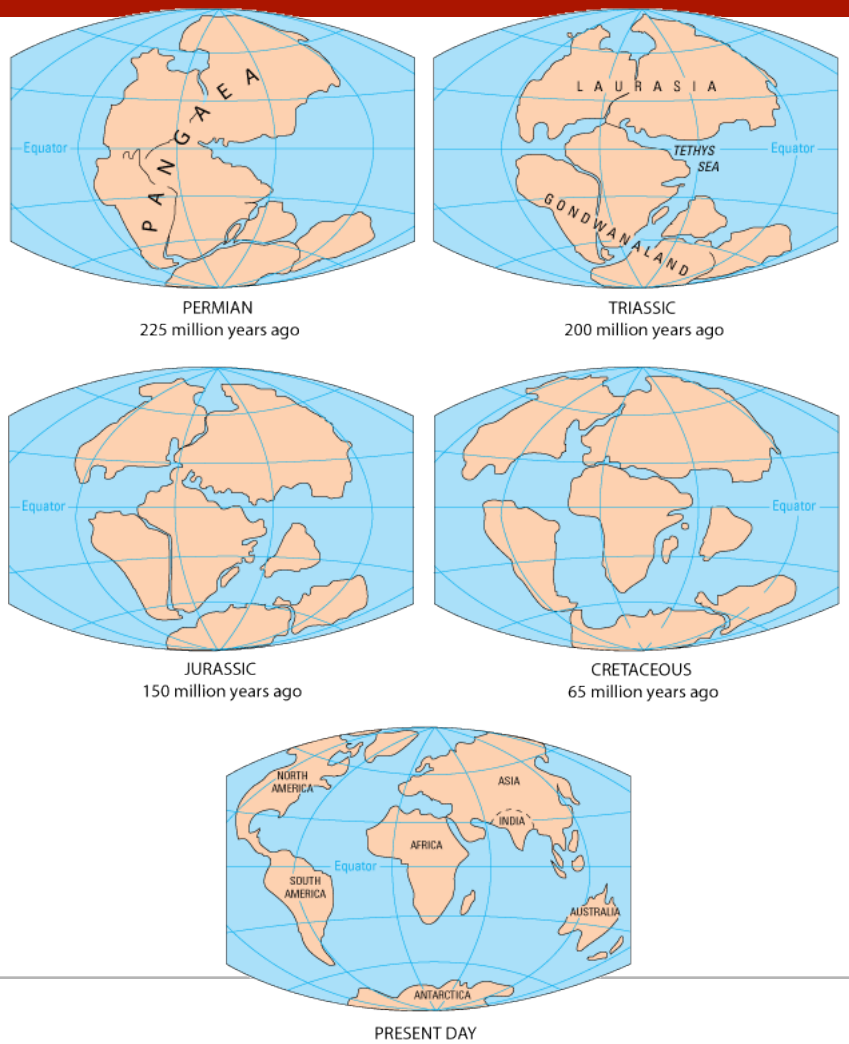
- Victorians noted how continental margins fitted together
- Certain geological formations extend from Africa to S America
- Distribution of glacial features in Permian rocks **cross the Equator**
- Many Permo-Triassic plants and animals fit a Gondwana distribution
- All combined by Alfred Wegener in 1912 in his proposal of continental drift


The distribution of glacial features can be best explained if the continents were part of Pangaea.



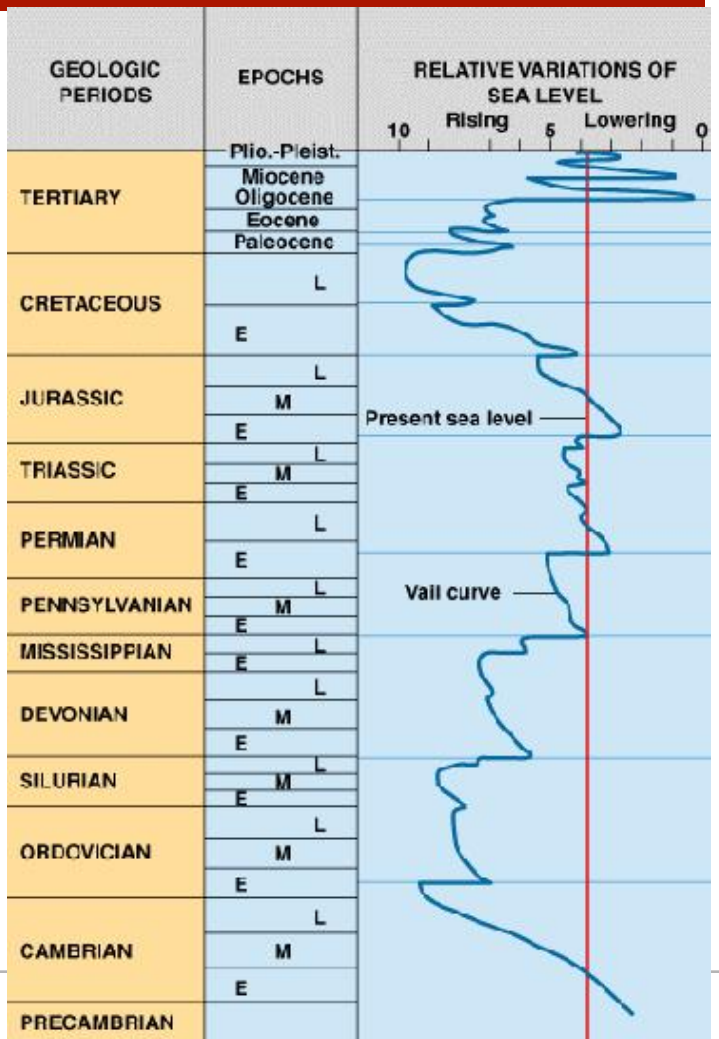
# Continental drift 2

- Continents and oceans have been changing throughout the history of the Earth
- Reconstructions back to 250 Mya are known in considerable detail, based on geology, geophysics, and palaeontology – can be extended back to 600 Mya with reasonable confidence
- Dinosaur distributions controlled by changes in geography through the Mesozoic



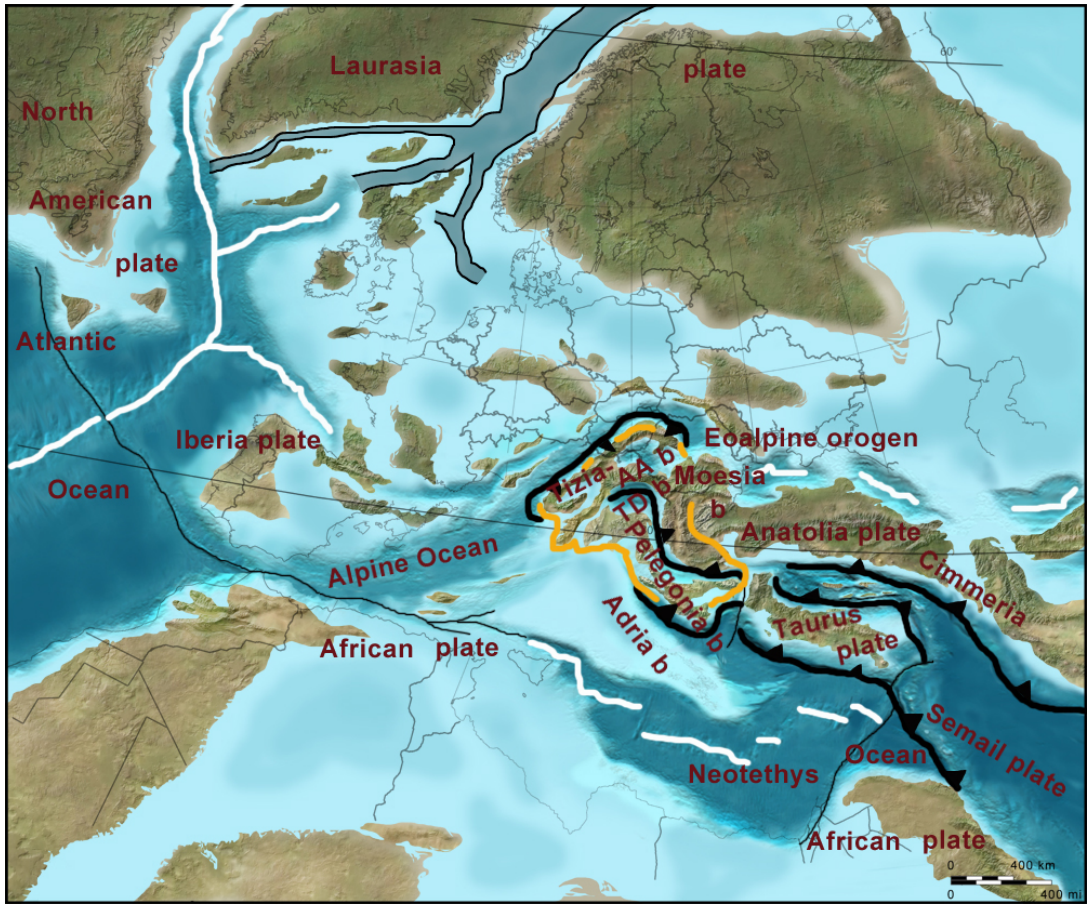
# Sea level change

- The distribution of continents, and especially of habitable areas, depended as much on continental position as **sea level**
- Sea level through most of the Mesozoic was higher than today; also no ice caps – link?
- Massive rise to in sea level through the mid Cretaceous – increase in mid-ocean ridge activity and warmer atmospheres…
- Seas flooded continental areas

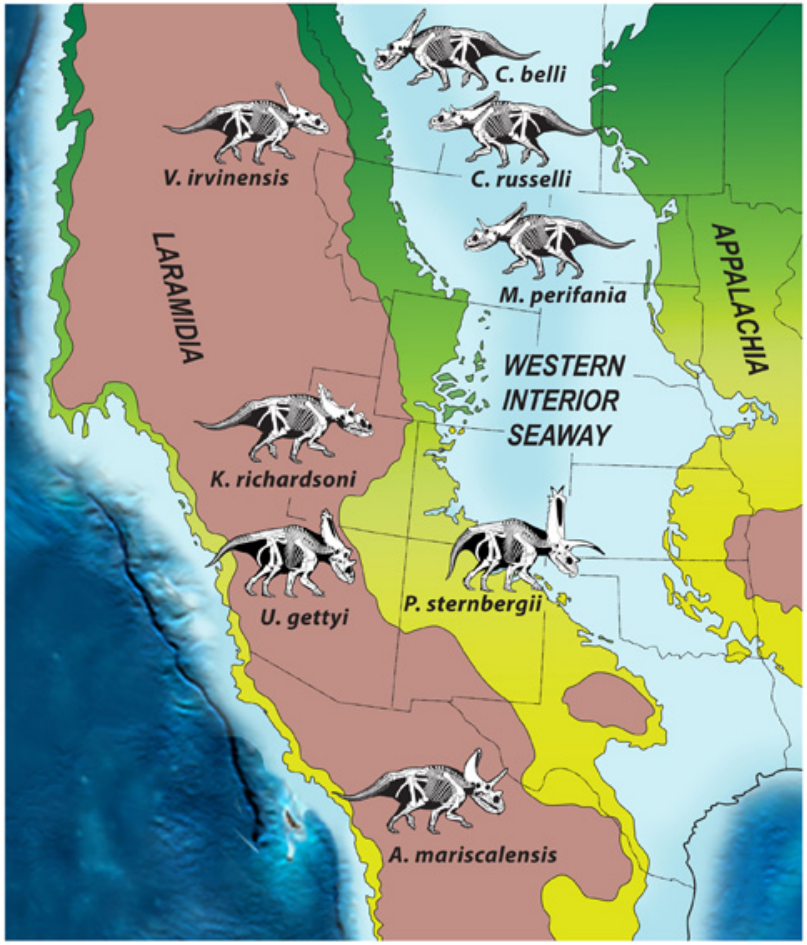


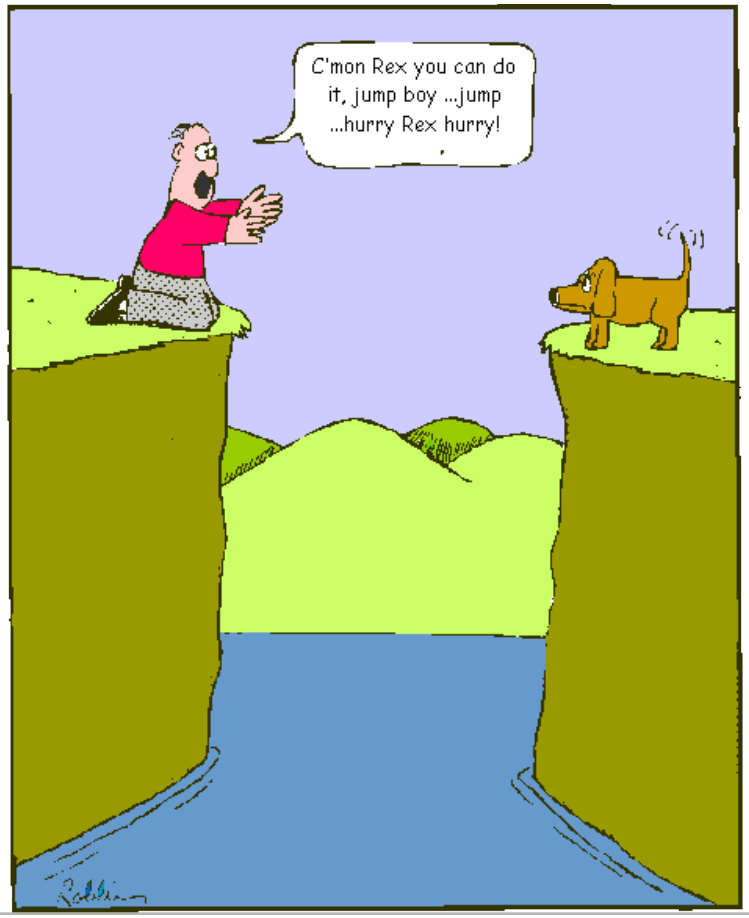
# Upper Cretaceous palaeogeography 1

- Sea level 100 m higher than today because no ice caps; also coincided with a time of massive mid-ocean ridge activity
- Time of massive chalk deposition in S England
- E Europe an archipelago
- Dinosaurs known from S Spain, S France, E Europe



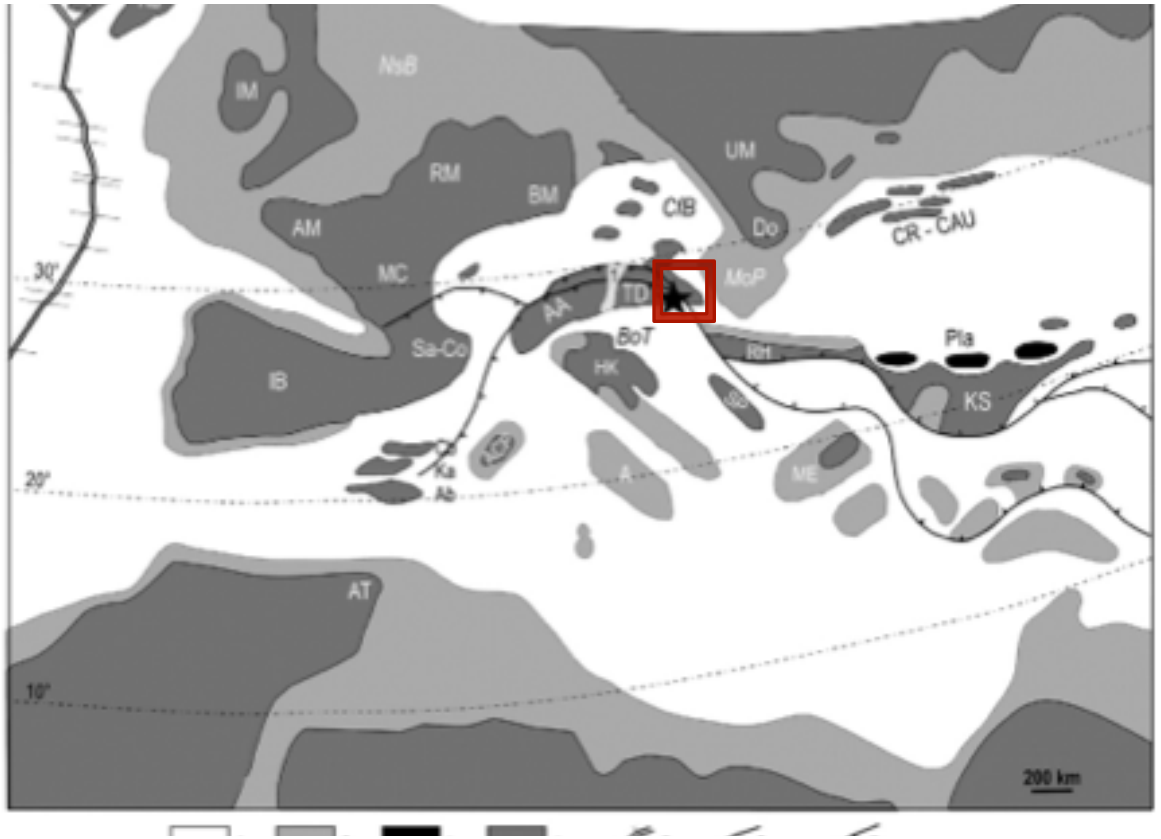
# Upper Cretaceous palaeogeography 2



# Upper Cretaceous palaeogeography 3

- Debate about whether Haţeg was an island or not
- Nopcsa said it was, and current evidence suggests he was right
- Geological reconstruction shows an area of 200,000 $km^2$
- Isolated for 40 Myr of Late Cretaceous



# The Haţeg fauna 1

- *Hatzegopteryx* a giant pterosaur – with close relatives throughout the world, arguably one of the largest
- Known only from isolated bones, so free speculation on size
- Wingspan of 10 m or more, according to some

# The Haţeg fauna 2

- *Elopteryx* a small theropod, known from isolated remains of the skeleton
- Once thought to be a bird, but a dinosaur, close to birds
- Close relatives in many other parts of the world, and not especially small or unusual
- No larger predators

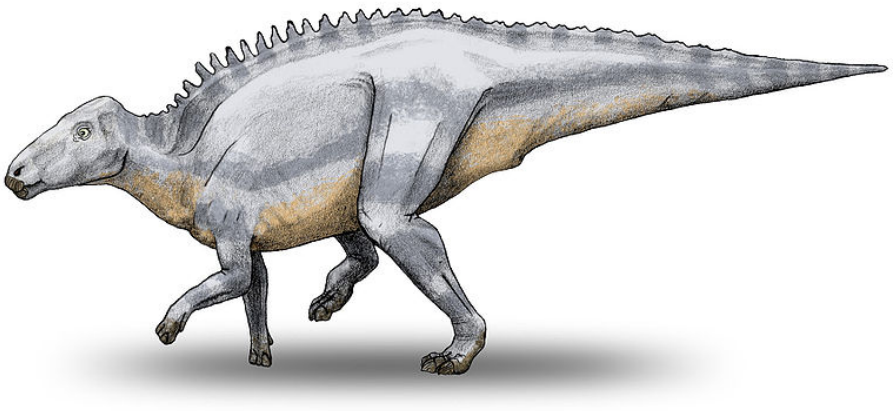

# The Haţeg fauna 3

- *Magyarosaurus*, named over 100 years ago, and included among the first bones found by Nopcsa
- A titanosaur sauropod, with relatives especially in southern continents – S America, India, Africa, Madagascar

# The Haţeg fauna 4

- *Struthiosaurus*, a nodosaurid ankylosaur, known from numerous isolated bones and armour plates
- A relatively primitive form for the laterst Cretaceous, with closest relatives living elsewhere some 55 Myr earlier

# The Haţeg fauna 5



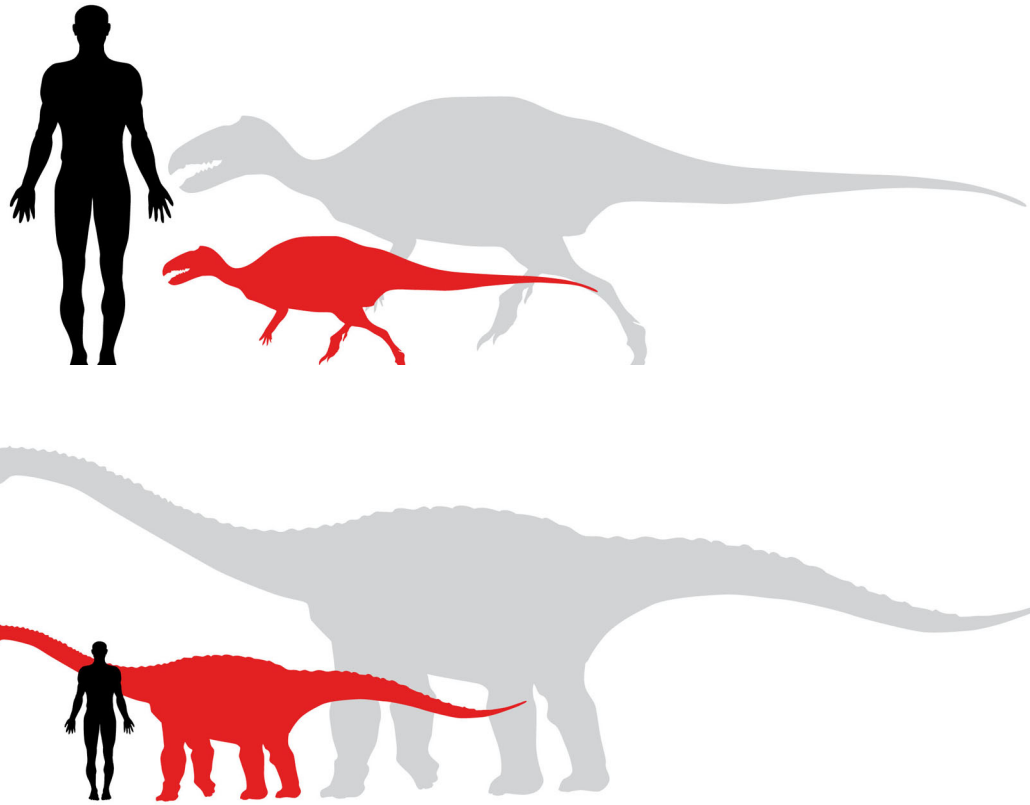

- *Telmatosaurus*, a hadrosaur ornithopod, about 4 m long
- Phylogenetically, it is the most primitive hadrosaur, sitting lower in the phylogenetic tree than coeval forms from N America and C Asia – closest to forms 15 Myr older

# The Haţeg fauna 6


- *Zalmoxes*, two species, known from many specimens, 3 m and 4 m long respectively
- Closest relatives from earliest Cretaceous, so 70 Myr earlier

# Dwarfs or juveniles? 1

- *Zalmoxes*, is half the length and one-eighth the mass of its nearest relatives
- *Magyarosaurus* is half to one-quarter the length of its nearest relatives and so one-eight or less the mass of its nearest relatives
- But are they dwarfs or juveniles?

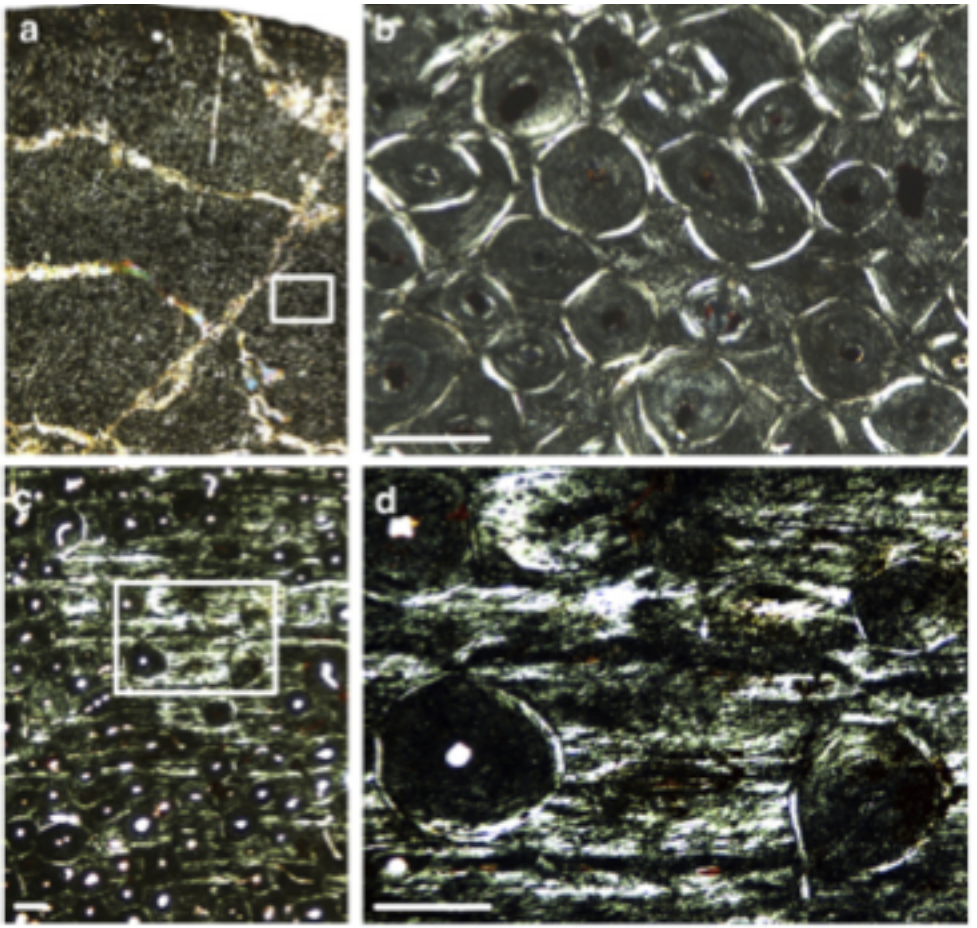


# Dwarfs or juveniles? 2

- *Magyarosaurus* humeri from Haţeg (right) range from tiny (left) to larger (right), suggesting a range in body size- but are the bigger ones fully grown?
- Larger bones show fusion of sutures, so suggestive of adult size
- Circumstantial – larger elements not found – but negative evidence
- Some decisive method is needed…

# Dwarfs or juveniles? 3

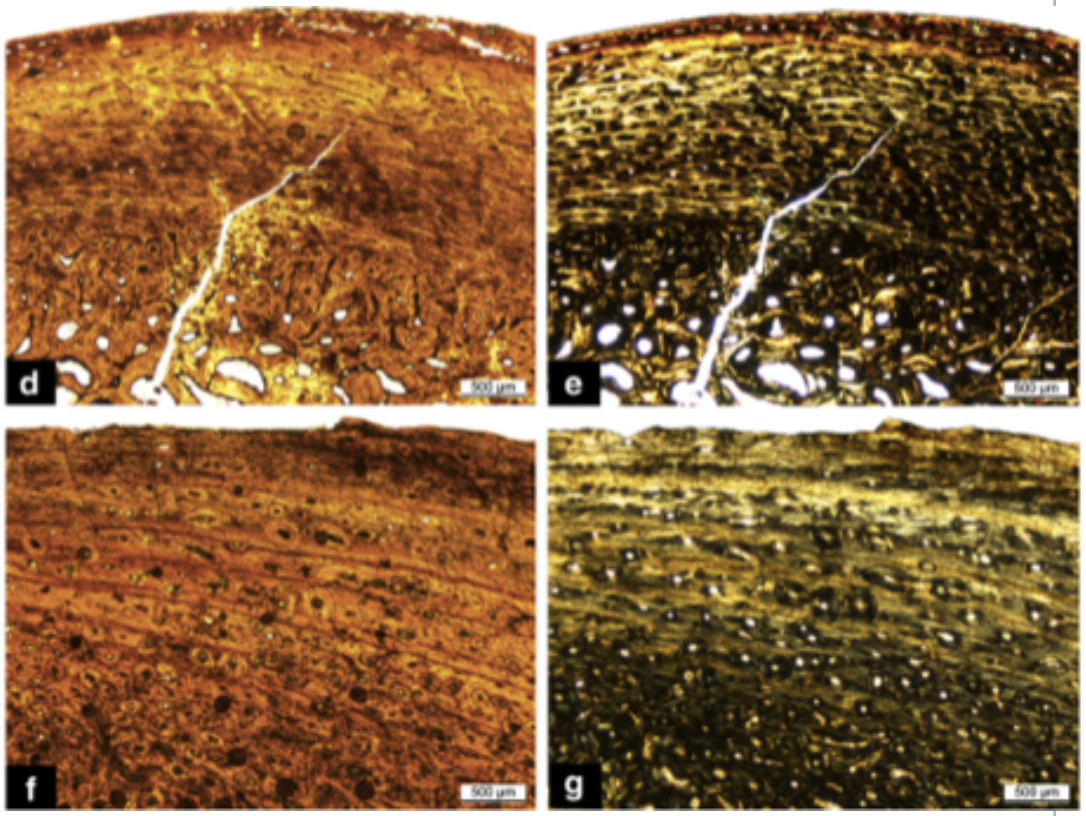
- Bone histology is the answer – dinosaur bones usually show all detail internally when sectioned
- Sections (right) of larger (top) and smaller (bottom) *Magyarosaurus* bones
- Note the advance of secondary Haversian systems with age – the largest individuals from Haţeg (top) show complete secondary remodelling as in adults from elsewhere




Benton et al. (2011)

# Dwarfs or juveniles? 4

- The same is true in *Telmatosaurus* (not shown) and *Zalmoxes* (right)
- Femurs of subadult (top) and adult (bottom) in polarized (left) and normal (right) light
- The subadult died at 7 years, the adult at 11. Note secondary remodelling limited to inner region and open osteons at outer surface in subadult; more widespread in adult

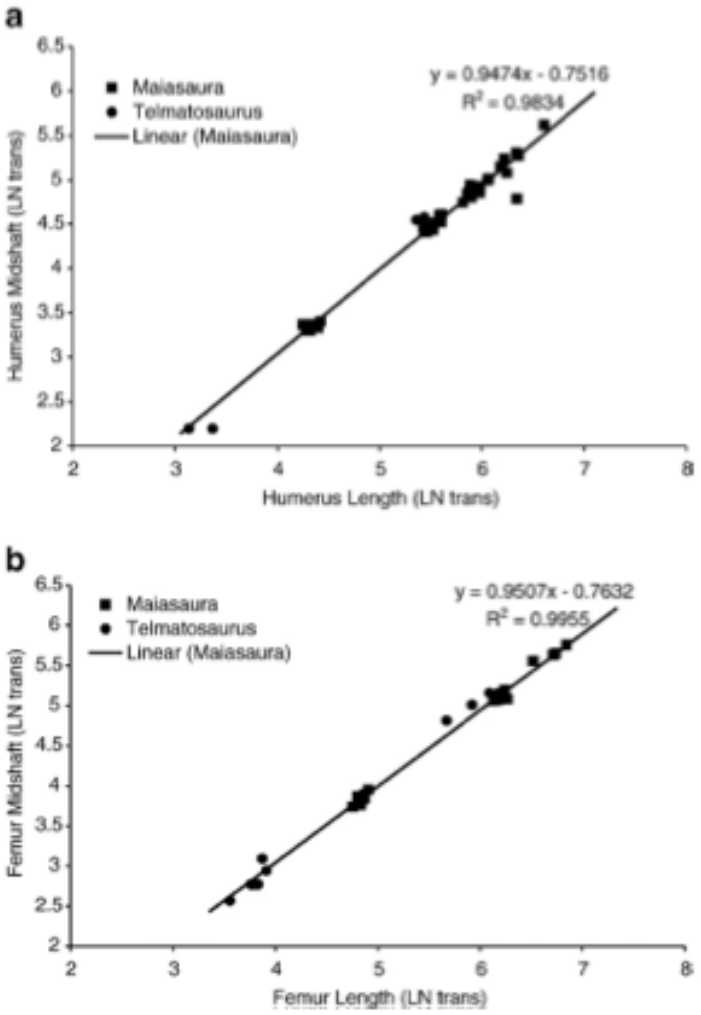



Benton et al. (2011)

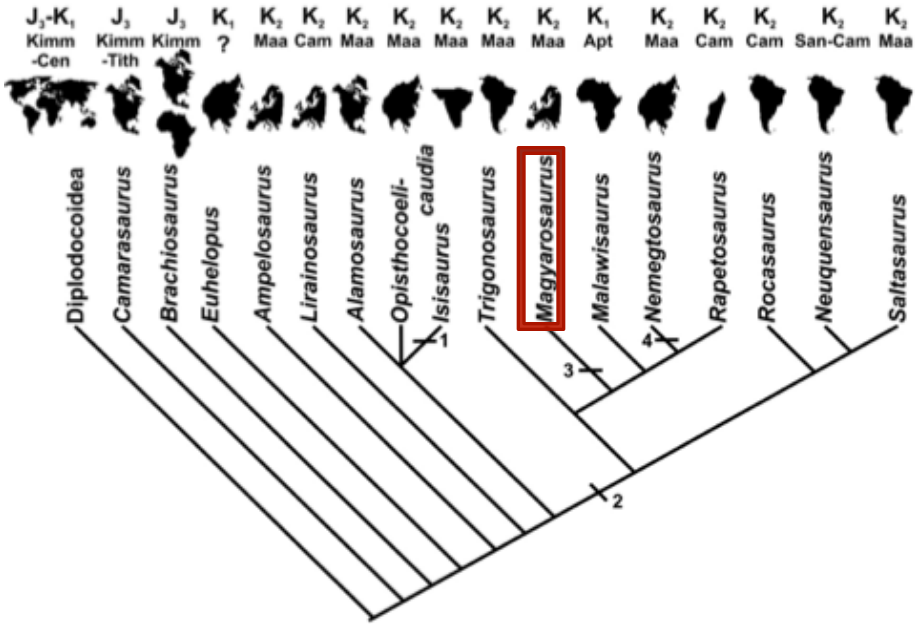
# Dwarfs or juveniles? 5

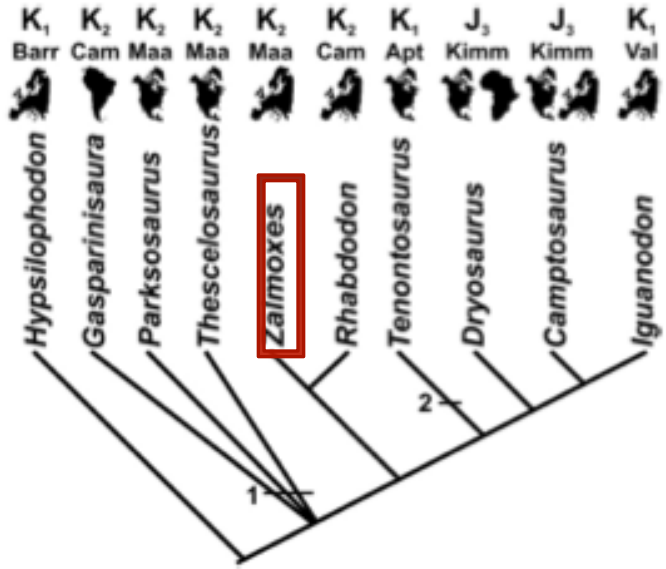
- Growth calculations for *Telmatosaurus* and its relative *Maiasaura* show that both forms fall closely on the same line for humerus (a) and femur (b)
- Suggests the same growth trajectory in both, but that it is foreshortened in *Telmatosaurus* – the latter becomes adult at smaller size than in its relatives
- Paedomorphic process ('juvenile adults', probably by progenesis (early cessation of growth)

Benton et al. (2011)



# Relicts

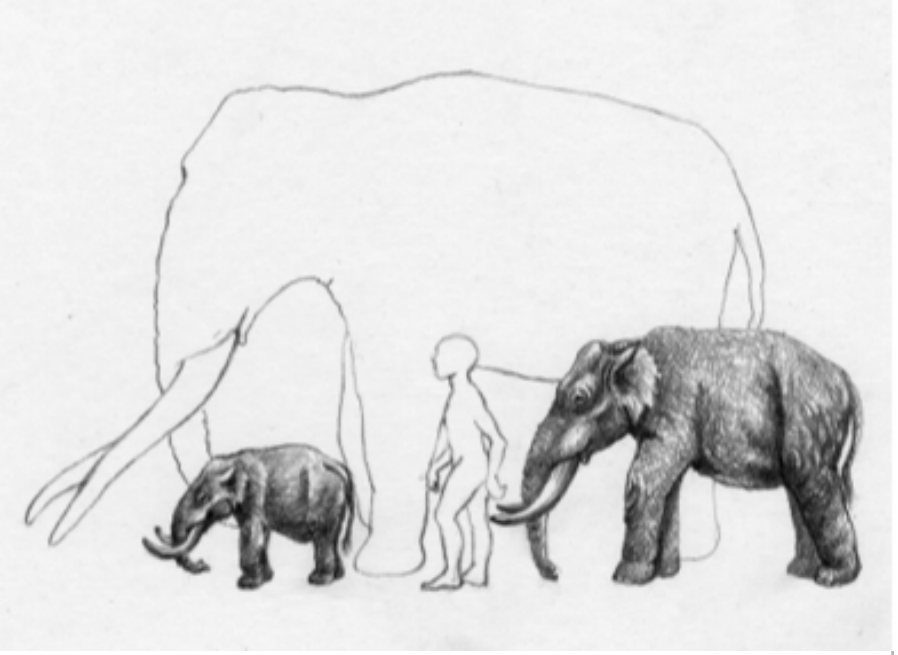



- In phylogenetic analyses, the Haţeg dinosaurs all fall among much older forms, often close to the origin of their clade
- Show palaeogeographic links with Europe, N America, and Gondwana
- Relicts – living on an island and evolving in isolation for 40 Myr+

# Island dwarfing 1

- Best known examples of dwarfing are miniature elephants from the last tens of thousands of years in the Mediterranean
- Dwarfs from Sicily and Malta (0.9 and 1.8 m at shoulder) compared to *Elephas antiquus* (ancestor), 3.5 m tall
- As sea levels fell during ice ages, elephants, and other animals, could get across to islands from Africa; then isolated by rising waters
- Mostly date from 1.0-0.4 Myr ago, and all extinct by end of Pleistocene (11000 y a).



# Island dwarfing 2

Why do large animals become small on islands? [Also small animals become large – giant rats]

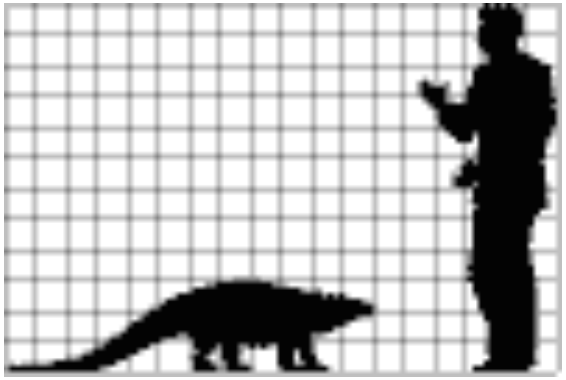
1. Ecological release – normal competitive/ predatory pressures removed.
2. Niche expansion – fewer species, so each expands its range of diet/size.
3. Resource limitation – less space and food -> dwarfing.
4. Optimization of life-history traits towards more r-selected modes

# Island dwarfing 3

- Other important examples of dwarfing in the Mediterranean include deer
- Dwarf deer from Crete (65 cm) and Sardinia (1 m) compared to mainland ancestor *Megaceros verticornis* from the mainland (2 m)
- Crete and Sardinia showed pigmy elephant, pigmy hippo, and pigmy deer, as well as large rodents and shrews
- Reduced diversity of mammals when compared to mainland, so mix of resource limitation and ecological release seem likely

# The Haţeg dwarf dinosaurs

- At least four of the Haţeg dinosaurs were quarter size or smaller (*Magyarosaurus*, *Struthiosaurus*, *Telmatosaurus*, *Zalmoxes*), representing three major groups (sauropods, ankylosaurs, ornithopods)
- Not juveniles (size ranges; bone fusions; bone histology), and compare closely with their normal-sized relatives in growth trajectories
- They all seem to have become dwarves by early offset (progenesis), meaning that they became adults earlier on the growth trajectory than their relatives
- Possibly related to limited food supplies, and the advantage of becoming adult sooner – also no really large predators, so no need to be huge
- Relictual – long evolution in isolation, while their relatives continued to change faster elsewhere



# Dinosaur renaissance

- Dinosaur diversity was substantial – and yet, despite intensive study, we keep finding new forms, even in the well-searched lands of Europe
- New research approaches (relative growth; bone histology) reveal evidence for earlier speculations
- What can we really know, though, about dinosaurian biology? See next dinosaur lecture…