Natural Sciences 360
Legacy of Life
Lecture 2
Dr. Stuart S. Sumida

The Enlightenment and Deep Time

Goals of today's lecture:

Show how biology was influenced by geology.

Show how geological knowledge (and thus biological knowledge) are product of scientific investigation AND the prevailing culture of the time.*

*Is today any different?

We’re going to do this during the time of the Enlightenment.

The time is the 18th century.

The Enlightenment was a philosophic movement marked by the rejection of traditional social, religious, and political ideas and an emphasis on rationalism.

Context for the time and place:

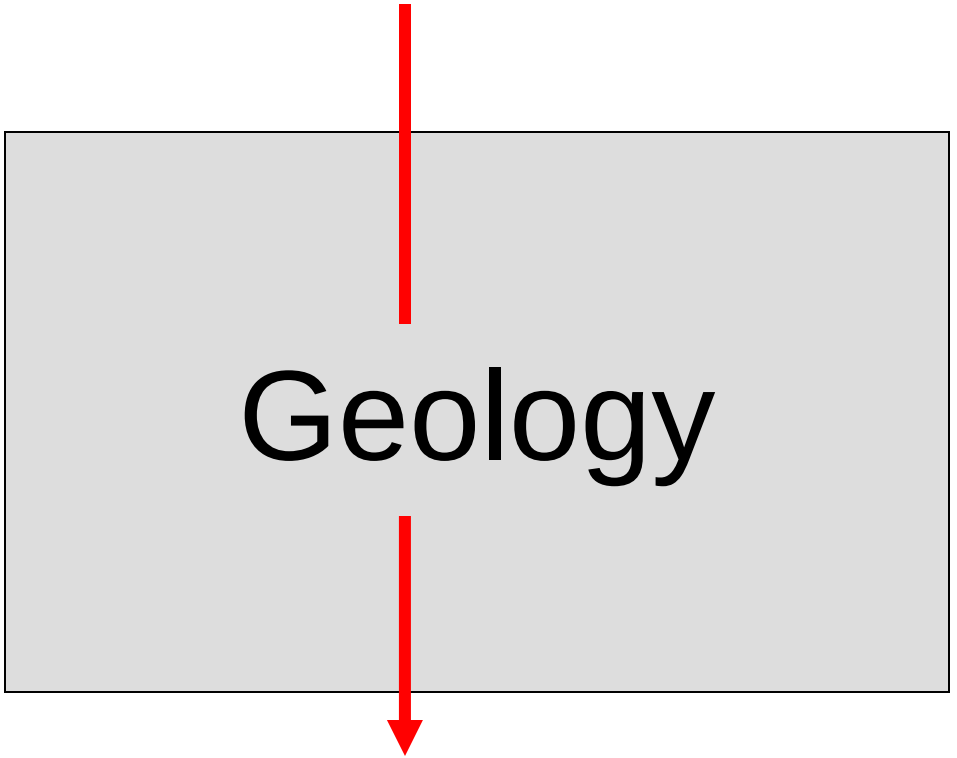
Reason and order are the basis of structures of government and of music.

Revolutions have shaken European monarchies.

States are becoming progressively more secular with separation of church and state.

Science based on observation and hypothesis testing has made many remarkable discoveries.

This lecture: Culture of the Enlightenment



Darwin and Natural Selection

We’re going to introduce these concepts and questions by taking a trip.

Time of the trip – the world of the Enlightenment at the end of the 18th century.

Place – We’ll begin is the small seaside resort of Lyme Regis in the south of England. The lecture will end about 100 miles and 100 years later outside of London at the home of Charles Darwin.

Lyme Regis: resort town…

…famous as a fossil collecting locality.

Amonite
80 million
years old.

(A shelled
relative of
squids,
octopi,
nautoloids,
etc.)

…the fossils of backboned marine reptiles known as ichthyosaurs…

…and fossil excrement (known as coprolites).

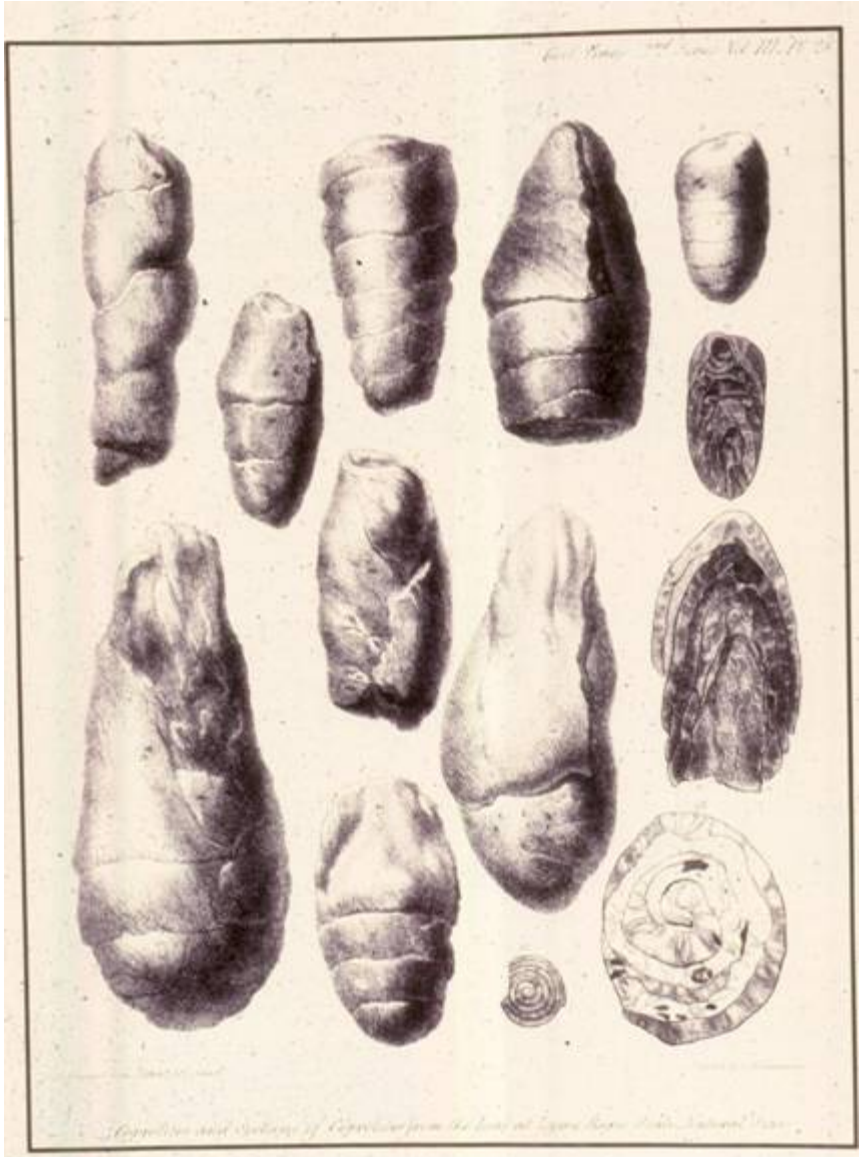


Figure 1 — Coprolites and sections of coprolites from the Lias at Lyme Regis, England, two-thirds actual life size. Reprinted from Buckland (1835) with permission from the Geological Society Publishing House, Bath, United Kingdom.

Although modern interpretation of fossils has changed a great deal in the last 250 years, interest in their observation, collection, and study has not.

Natural Theology (late 16th century to well into 19th century):

The Divine order of Creation manifested in works of Nature. (By studying nature, it was presumed that it was possible to understand the will of the Creator.)

Fossils were a popular such subject: were they evidence of logic hidden in rocks or of species of the past that were unlike those living today?

By the mid 17th Century the famous French comparative anatomist Cuvier' accepted the notion that fossils were the remains of ancient organisms.

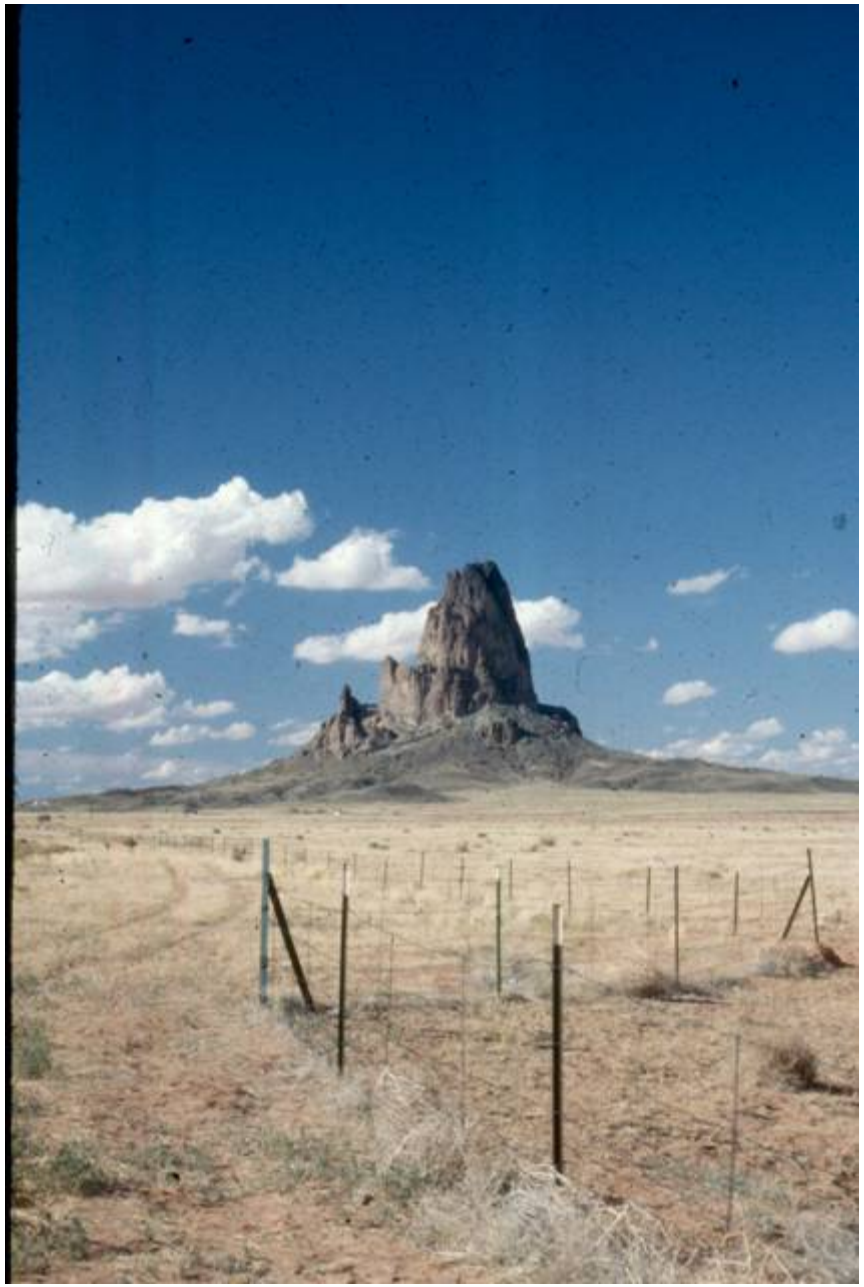
Why? They were different. They were found found in differing layers of bedrock.

(Cuvier thought they were serially extinguished species – say from a flood – that were then replaced with progressively better species.)

But, both fossils and growing geological recognition of differing layers in bedrock suggested that the earth might be older than what GENESIS* allows.

*Regardless of version.

There is no question – GEOLOGY HAPPENS.



Digression to rules of scientific terminology

Carl von Linne (Linneus)

Binomial nomenclature for species names.

Genus: *Homo*
Species: *Homo sapiens*; *H. sapiens*
(Always italicized; genus capitalized, species not.

Cosmic Order and Age of the Earth

Aristotle: time eternal, unchanging perfection of rules.

Judeo-Christian texts: flow of time is linear.

Most famous Biblical chronologies:
- **Julius Africanus placed creation at about 4500 to 6000 years ago.**
- **Chronology composed for King James Bible: Date of creation is noon, October 23rd, 4004 B.C.**

(Everything as we know it is a Scorpio.)

But the problem was: the geology was too compelling.

How could the geological features of the earth been sculpted as they were seen in such a short period of time?

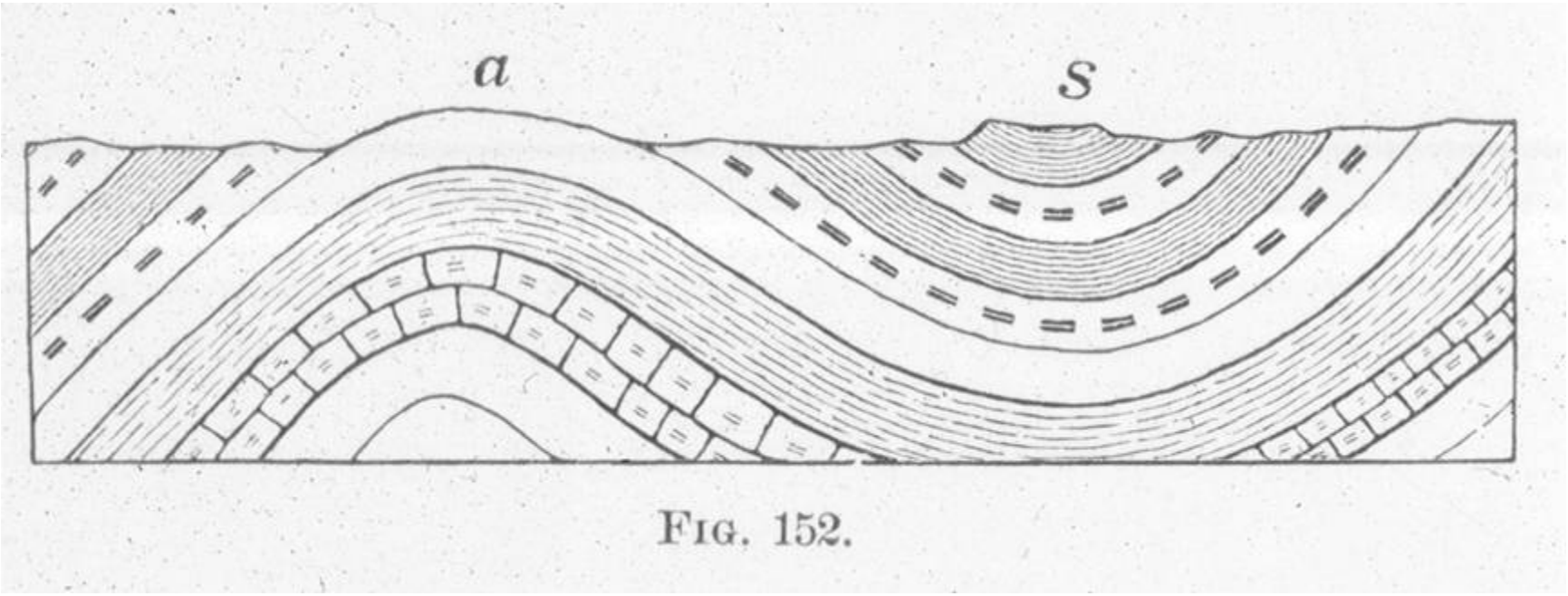


FIG. 152.

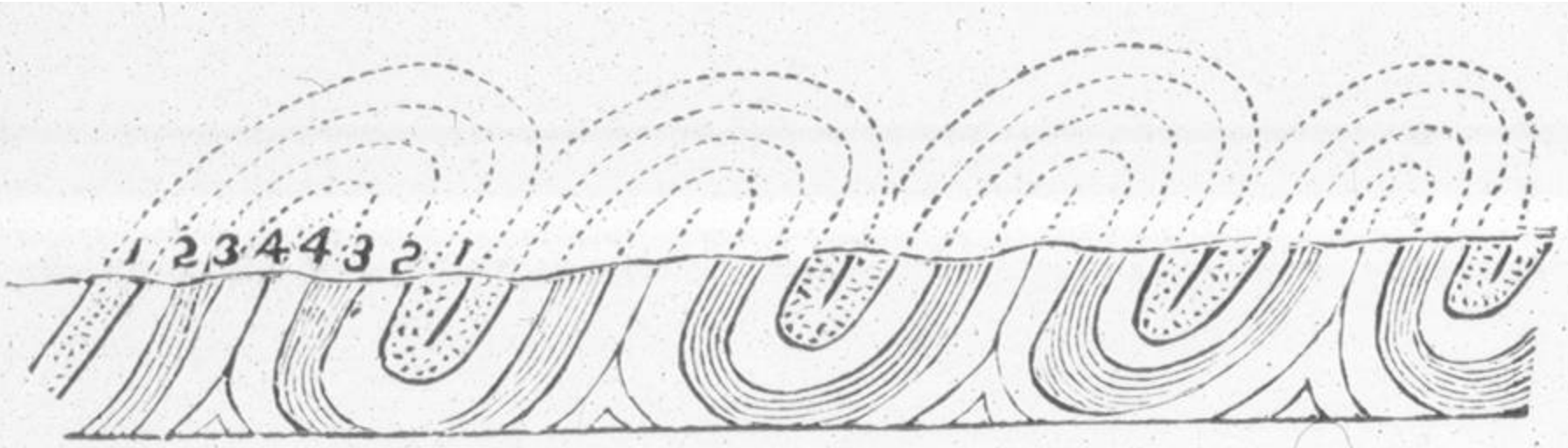


FIG. 151.

An unconformity:

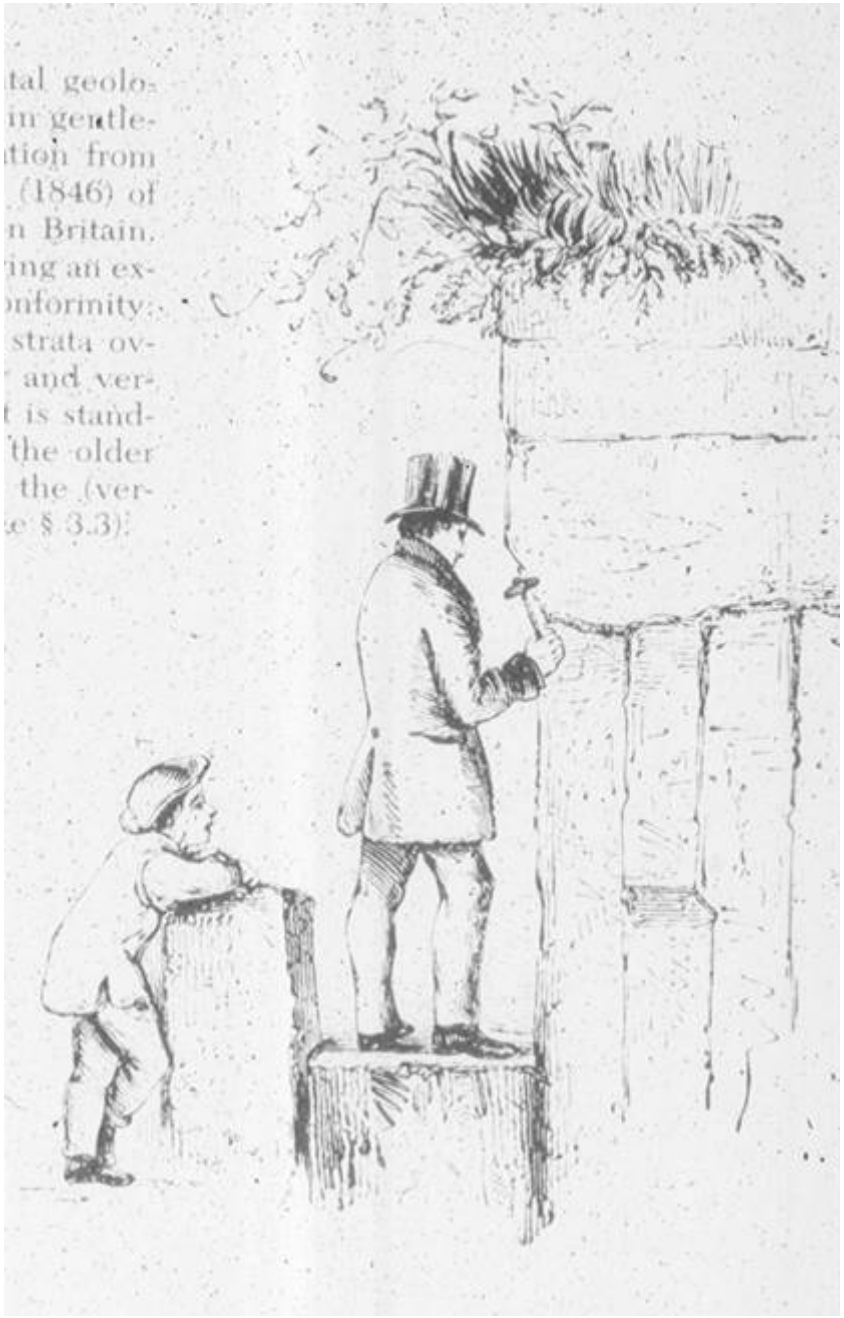
Scholars of the Englightenment generally favored a non-literal interpretation of scripture.

Issac Newton altered terms of debate by demonstrating that observation and data collection were more important and reliable than reliance on dogma.

Thus, many people curious about the age of the earth attempted to construct experiments to determine its age.

The results of these experiments gave ages as much as 75,000 years(!)

But again the rocks. In England, differing layers are well exposed and often easily interpreted. Thus, England became a center of considering how those layers got there, and how long it must have taken.



Geology in a social context:

English geology was done by “gentleman scientists.”

The core controlling English geology was upper class.

Fig. 4.1. Adam Sedgwick in 1833, from a portrait by Thomas Phillips.

William Buckland: professor of geology, Oxford University and ordained minister in very rich parish.

Adam Sedgwick (left) earned more from his church appointment than he did as a professor.

Fig. 4.4. Henry De la Beche in 1842, from a sketch by William Brockedon.

Henry de la Beche: born wealthy, but fell on hard times. Thus, he was often outcast relative to richer, church-connected geologists.

Charles Lyell: trained as a lawyer, prodigy in geology (but that paid poorly).

So,he took to writing. His most famous work: *Principles of Geology* (in three volumes)

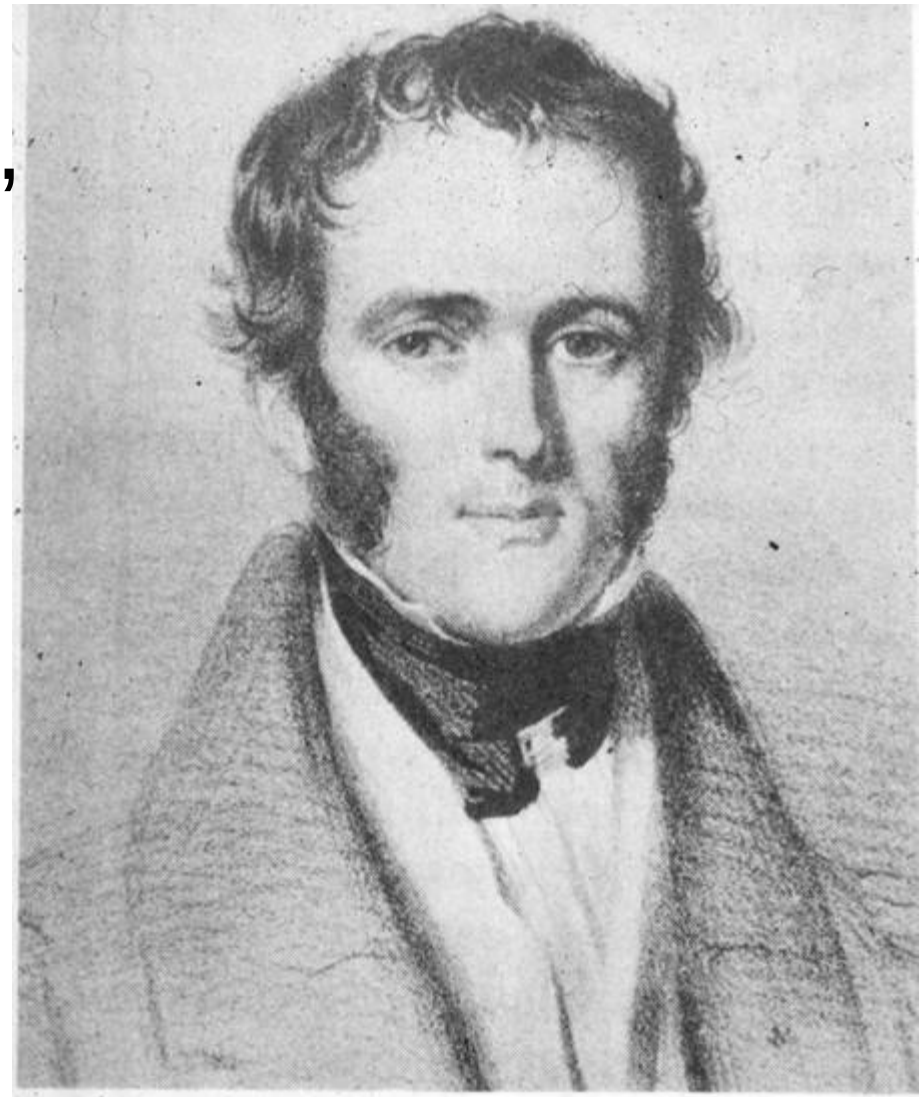
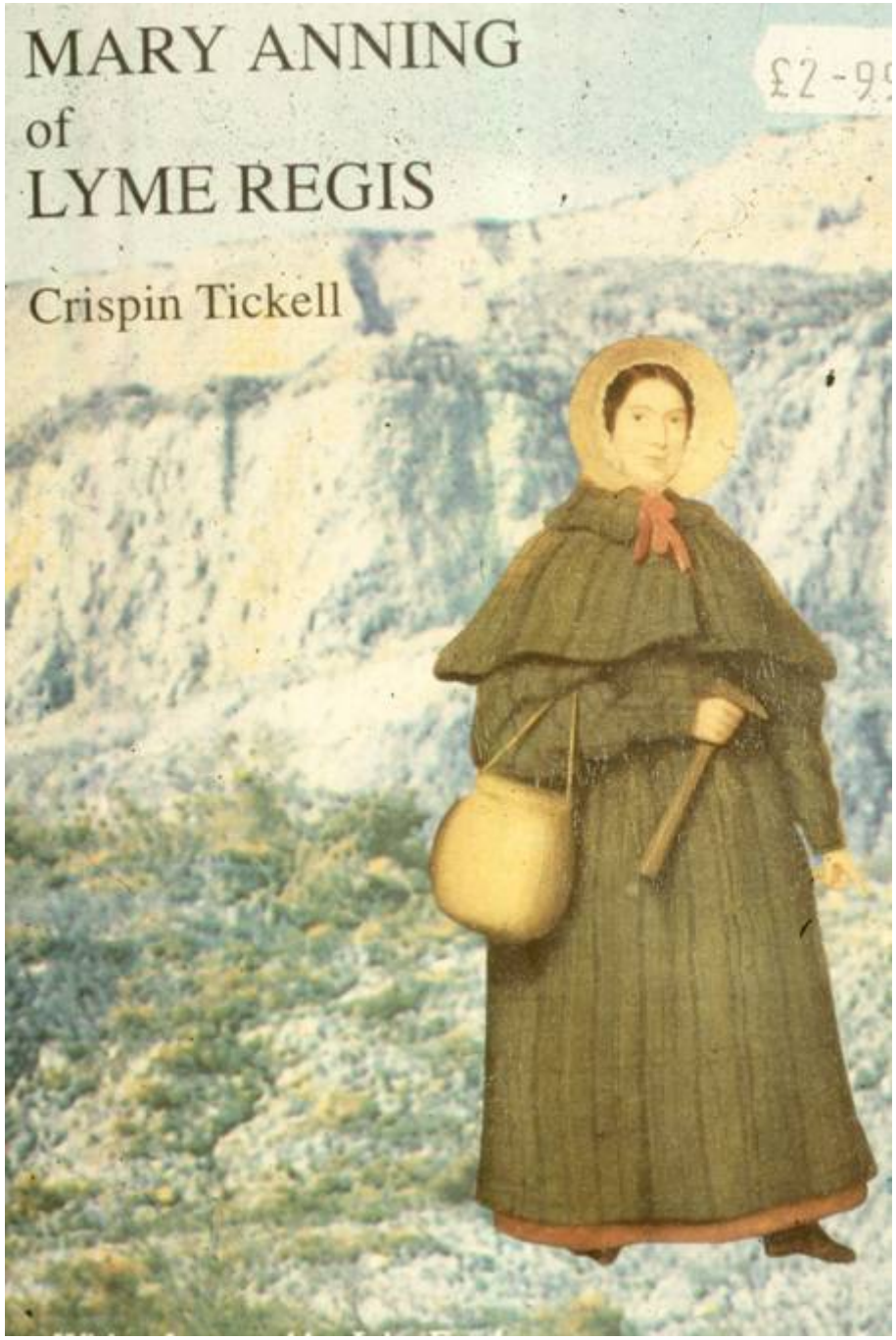


Fig. 4.6. Charles Lyell in 1836, from a portrait by J. M. Wright.

Lyell championed the concept of **UNIFORMITARIANISM** – the concept that the physical processes and physical laws (gravity, etc.) that we see around us today have not changed over time.

Enter Mary Anning: A woman of “low birth” but a remarkable geologist and fossil hunter who lived in the village of Lyme Regis.*

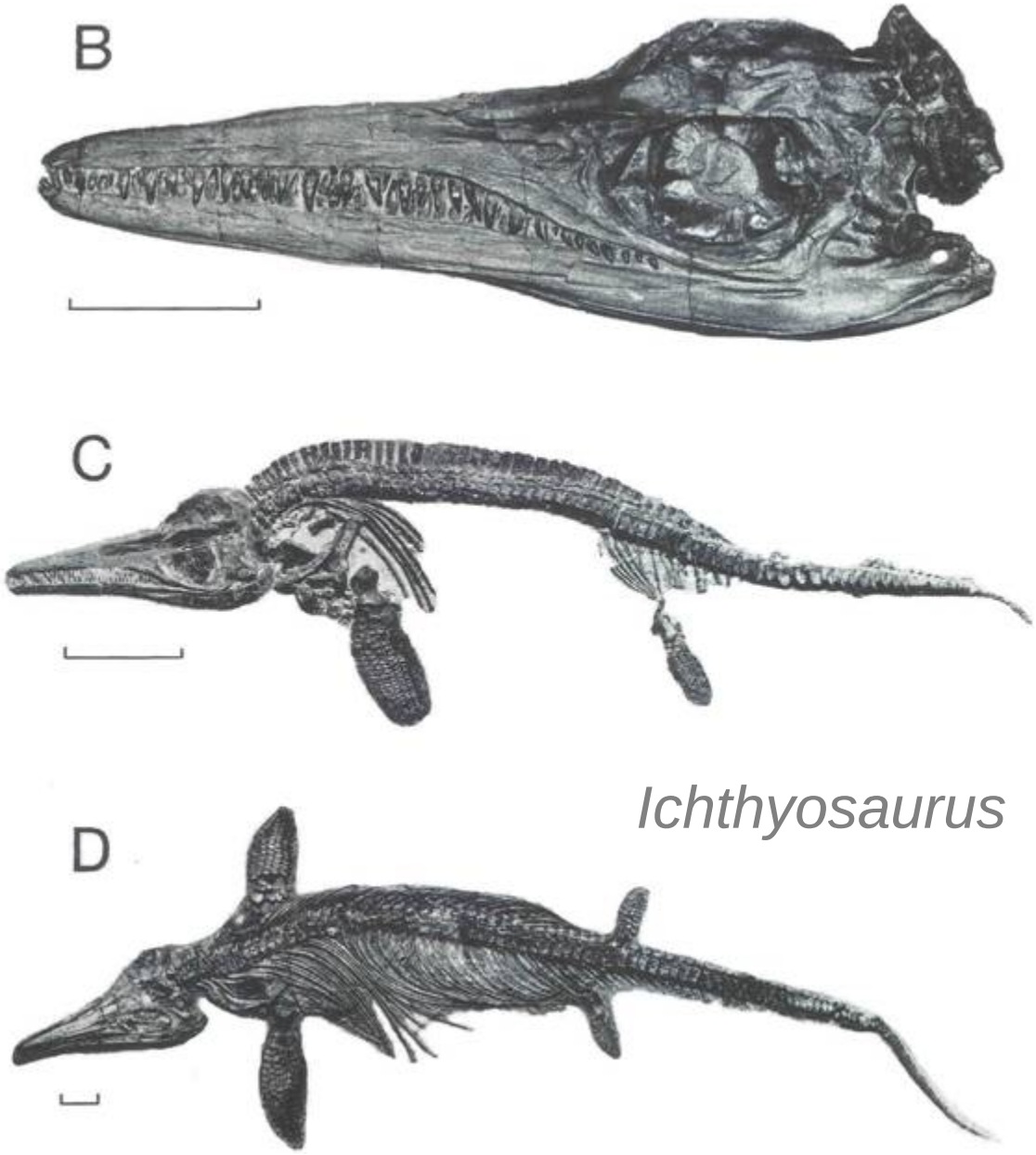
*Best known as where Jane Austin lived for a time.


MARY ANNING
of
LYME REGIS
Crispin Tickell
£2-9

Mary Anning supplied the gentleman scientists with fossils and data. (She sold some specimens to the British Museum for quite a bit of money.)

Reconstructions of the past were now created for the purpose of educating the middle classes.

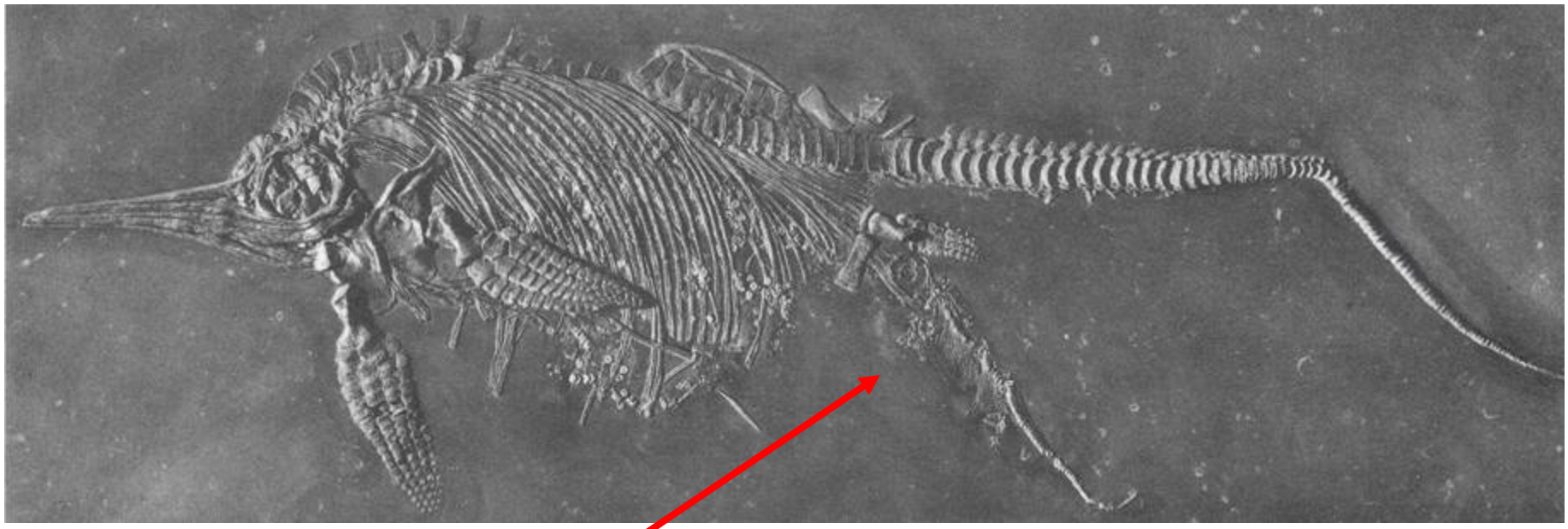
Fossils such as the ichthyosaurs she collected stirred the public's imagination.



Ichthyosaurus

Highly modified skull: large orbit, reduced cheek region, elongate snout.

Most highly specialized of marine reptiles. They converged on fish and cetacean forms.



Juvenile at moment of birth.

Juvenile *Ophthalmosaurus*

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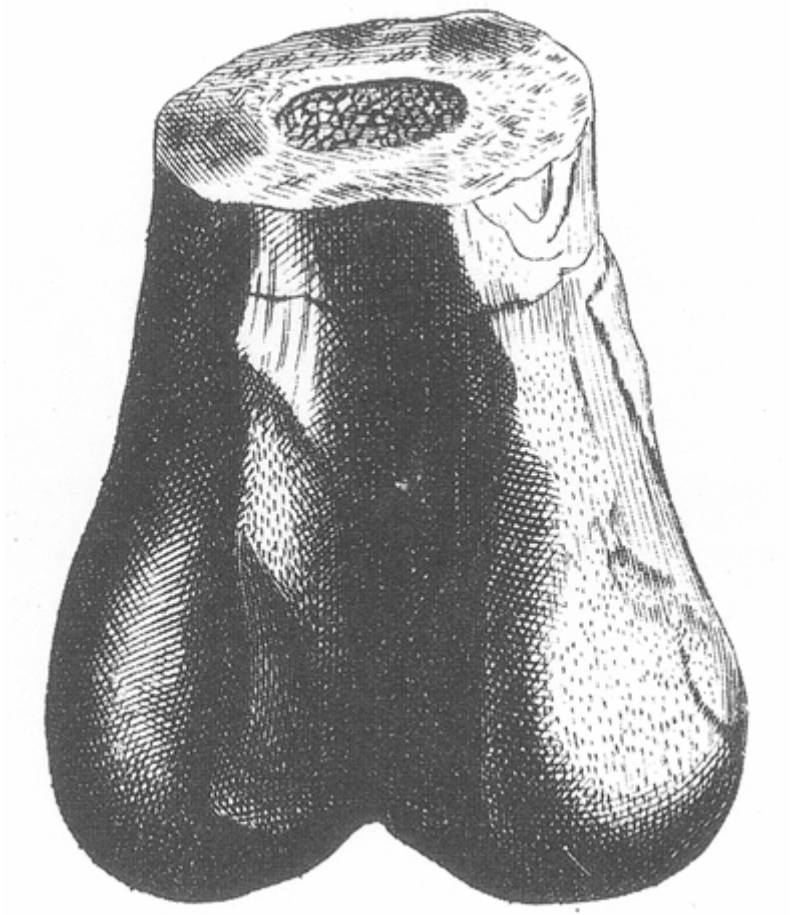
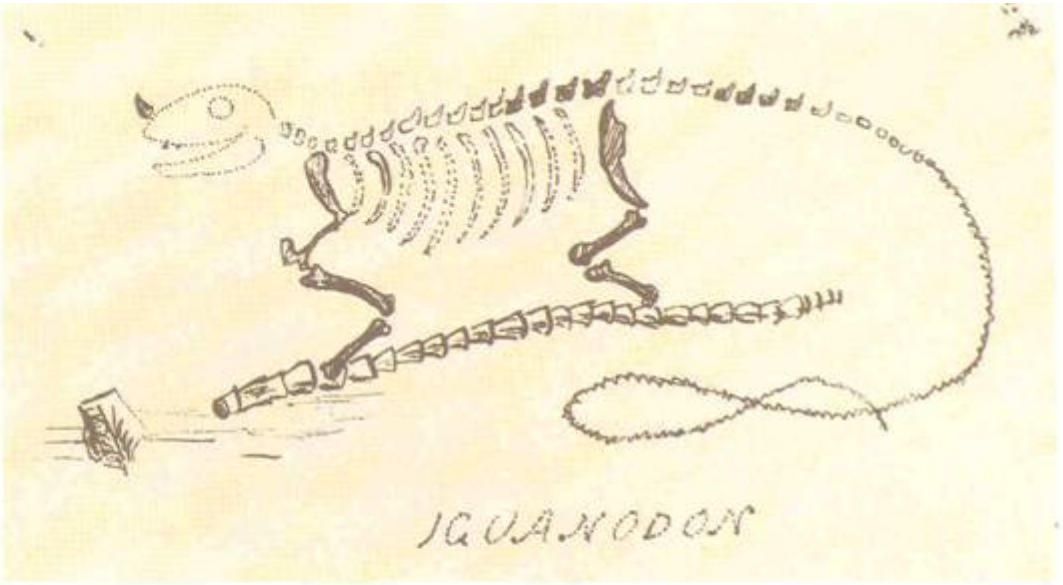
“Duria antiquior”

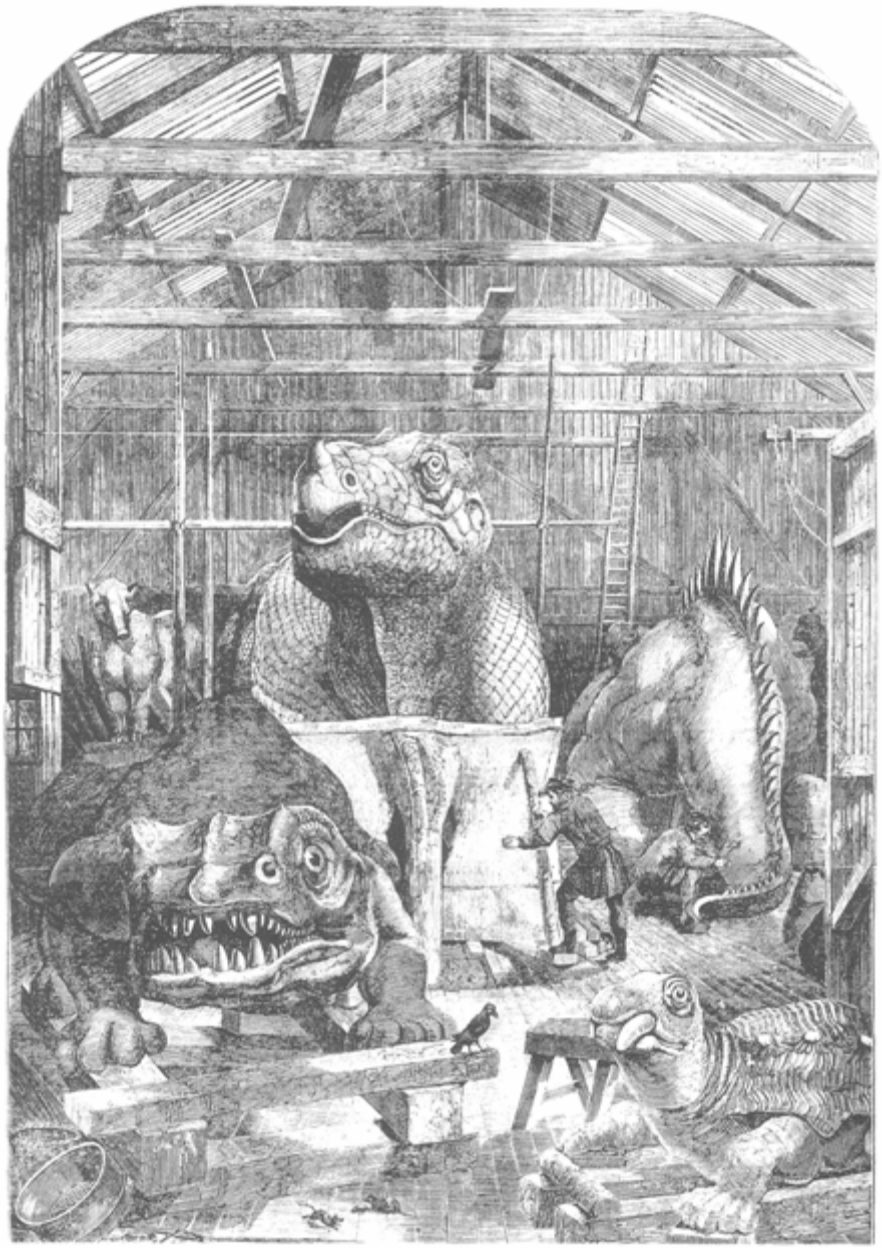
The first dinosaur ever found, *Iguanodon*, also came from Britain (and later Belgium). This also attracted an enormous amount of attention.

Iguanodon was the first dinosaur fossil ever found, the distal part of a femur, mistakenly identified as "*Scrotum Humanum.*"

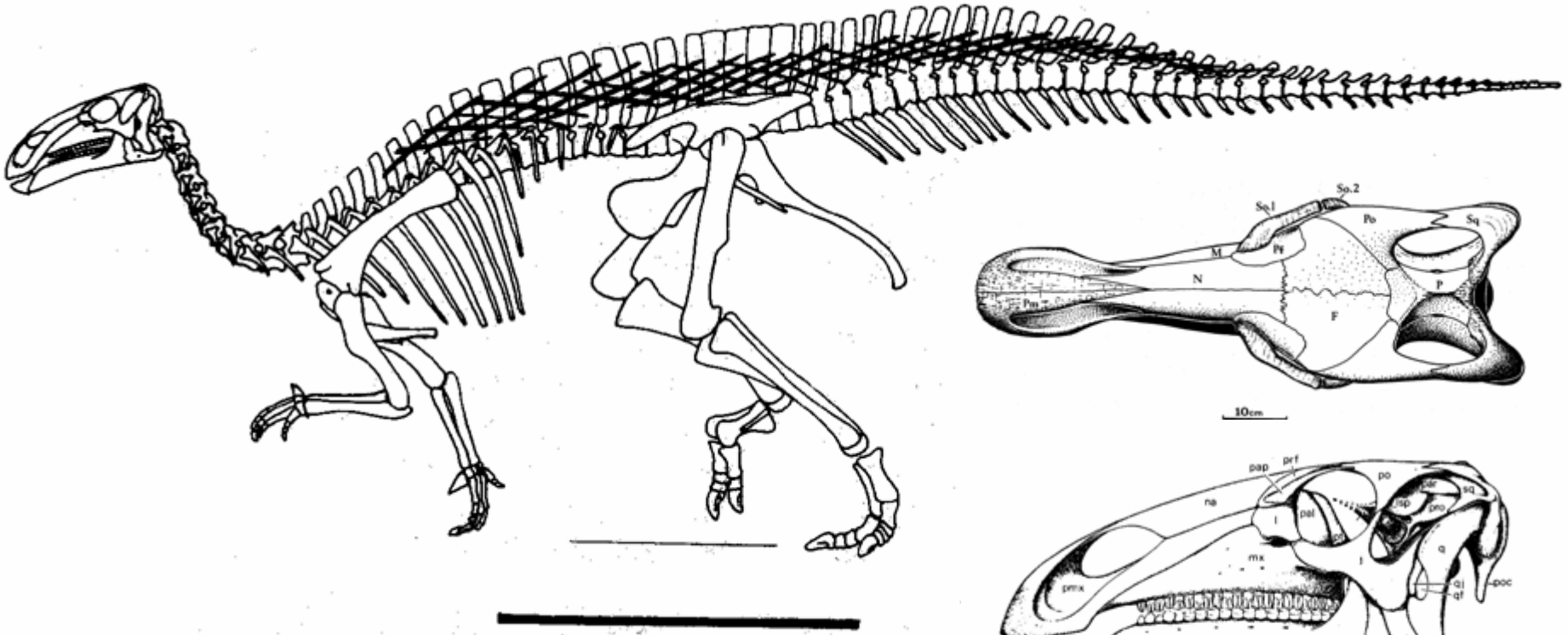


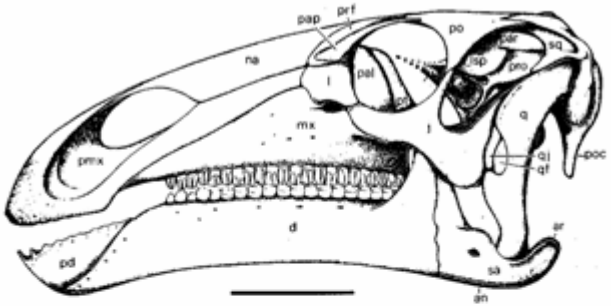
As the first dinosaur ever found, *Iguanodon* has had lots of time to be misinterpreted.

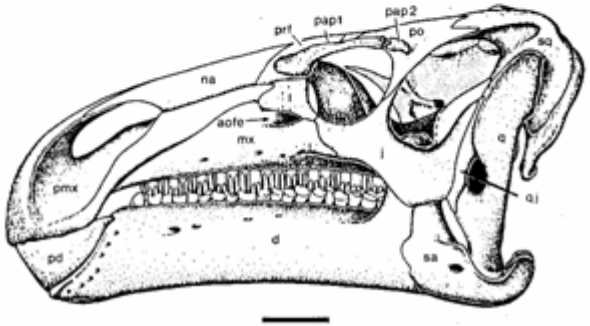




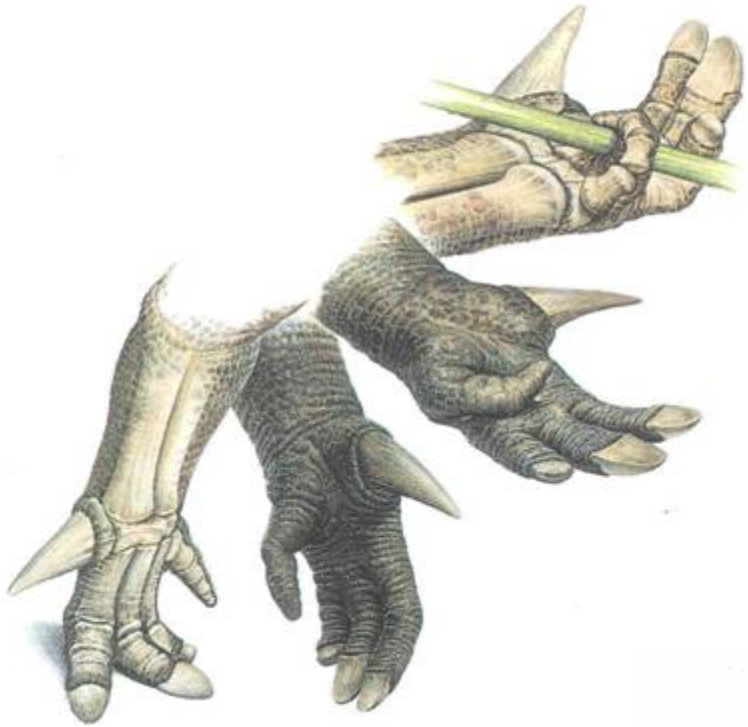
Waterhouse Hawkins: The Crystal Palace

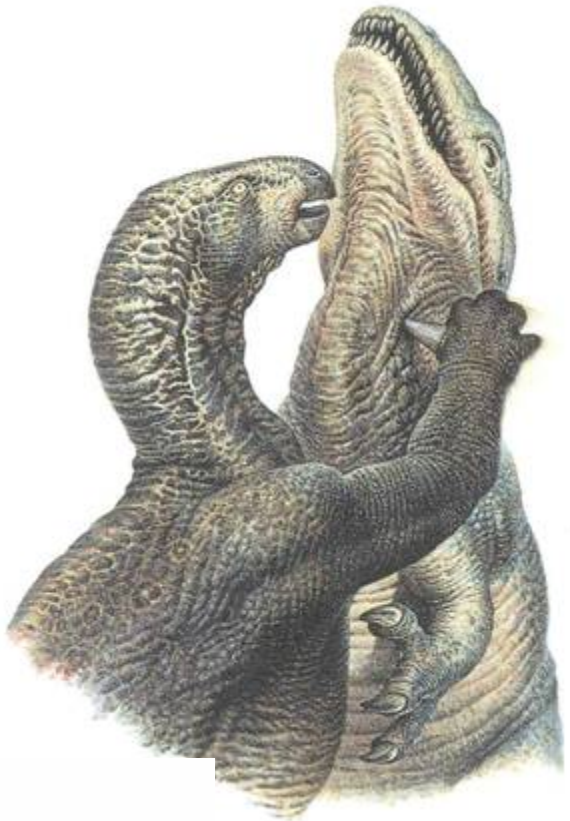






Iguanodon atherfieldensis





***Iguanodon*, manus in opposition.**

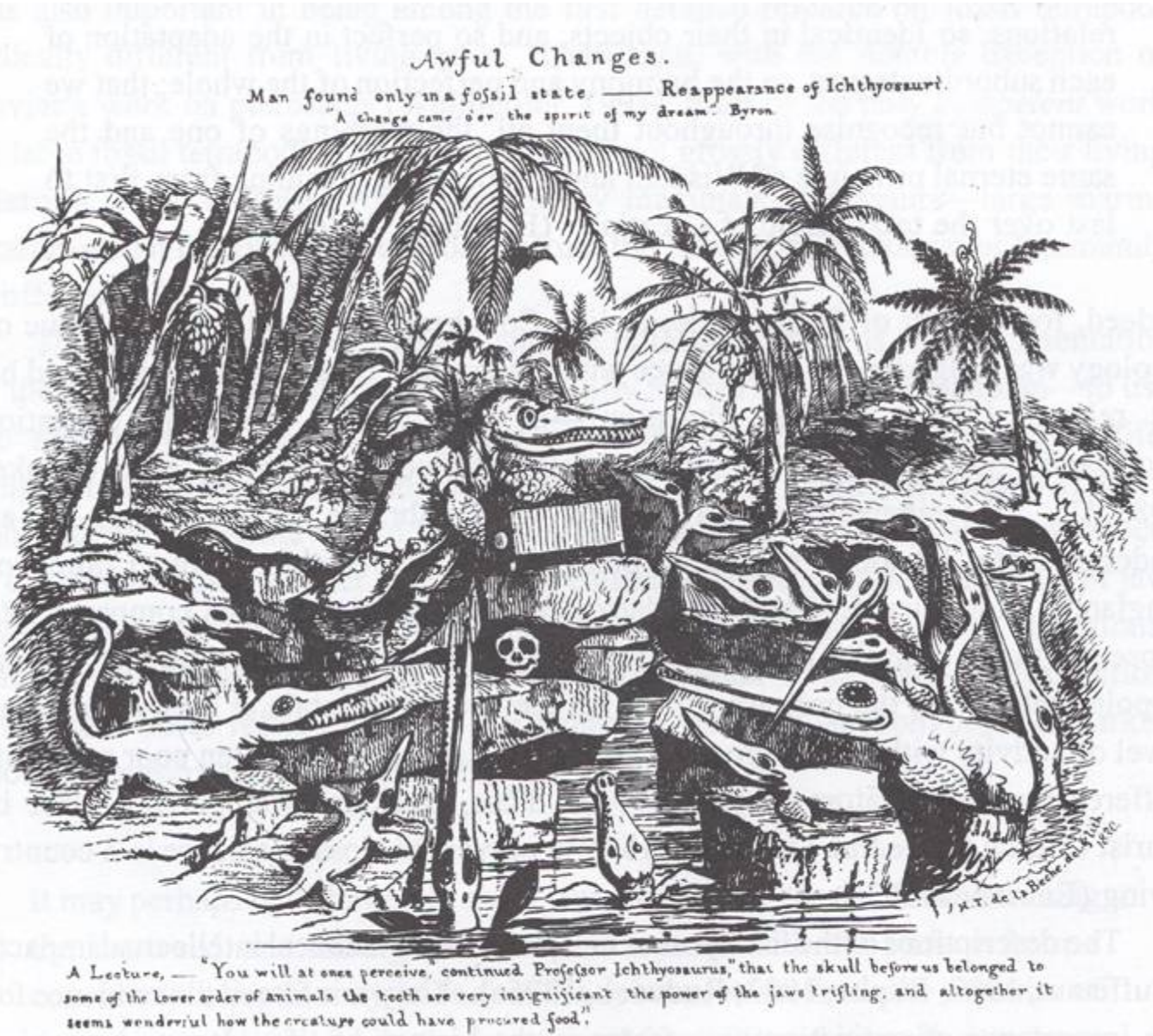
Recall that Lyell championed the concept of **UNIFORMITARIANISM** – the concept that the physical processes and physical laws (gravity, etc.) that we see around us today have not changed over time.

Geologists and paleontologists had come to agree – at least in part – that fossils suggested that organisms changed over time.

But it took Lyell's revolutionary thinking (and later Darwin's genius) to come up with a MECHANISM for evolutionary change.

In other words, Lyell's concept of uniformitarianism provided the amount of time necessary to explain the diversity of organisms and structure seen by scientists without invoking an untestable belief system.

(Not everyone agreed…)



The end of our trip: Down House, home of Charles Darwin.

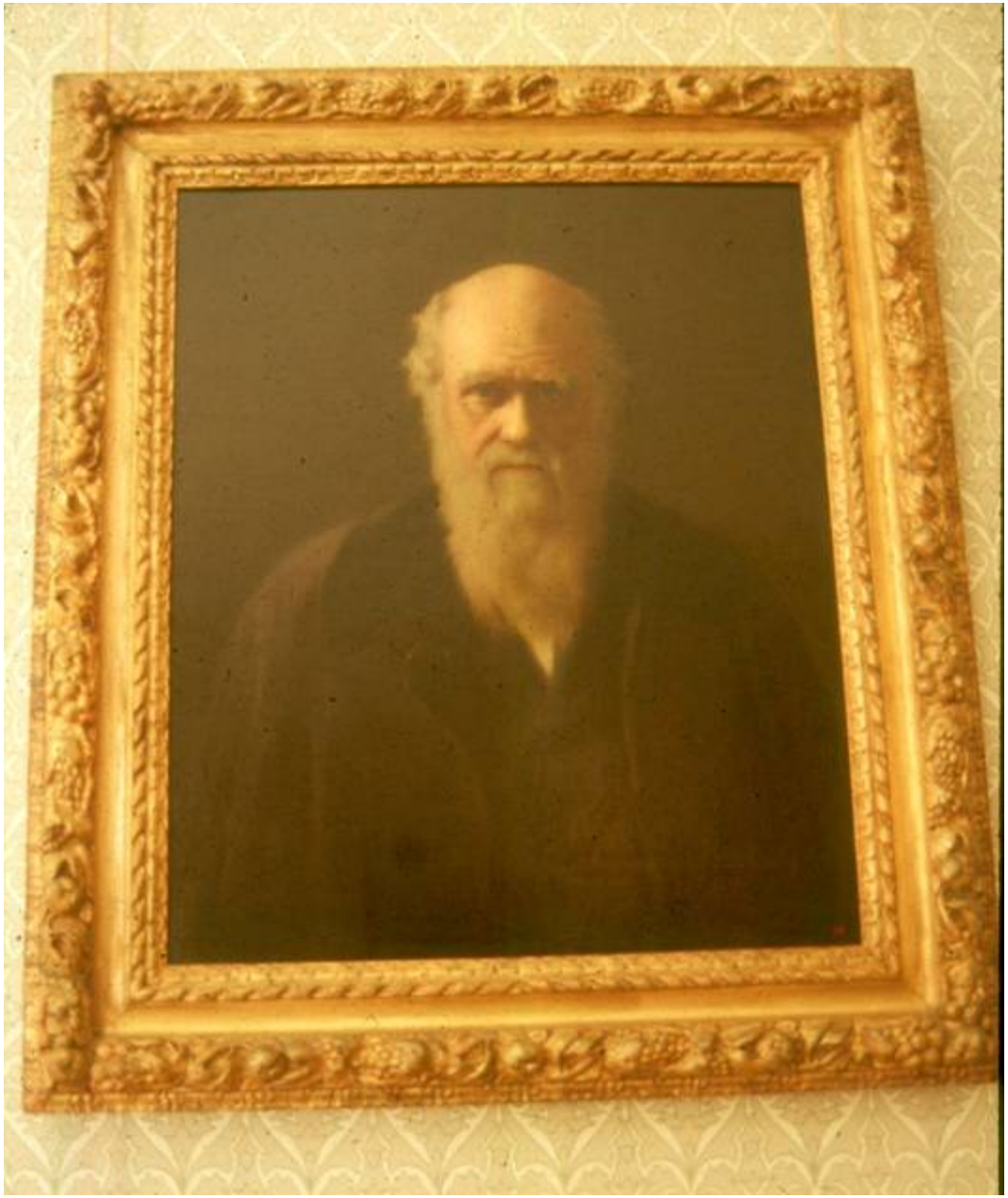
Darwin:

- An early slacker.
- Trained to be a minister.
- Uncle was Josiah Wedgewood.
- Grandfather Erasmus was a famous naturalist (who believed—radically at the time—that species could change over time. But he didn't know HOW.)

Darwin was greatly influenced by Lyell and his work. He took volume I of *Principles of Geology* with him on his famous voyage on the Beagle.

On the Galapagos Islands and elsewhere, he saw a great diversity of organisms.

Lyell's thinking allowed him to conceive of enough time for change to occur in populations over time.



Darwin's formulations in the *Origin of Species*:

1. Natural variation occurs by chance in populations.
2. Scarce resources limit populations.
3. Individuals with chance favorable variations will be more successful and produce more offspring. (Differential reproduction.)
4. These favorable traits will be passed on to offspring.
5. Over the combined length of geological time, the accumulations of chance events combined with natural selection would be sufficient to effect great changes in species.