

Evolution: The Basic Principles



Dorset Coast, geological layers –strata–



The Alps: layers of rock

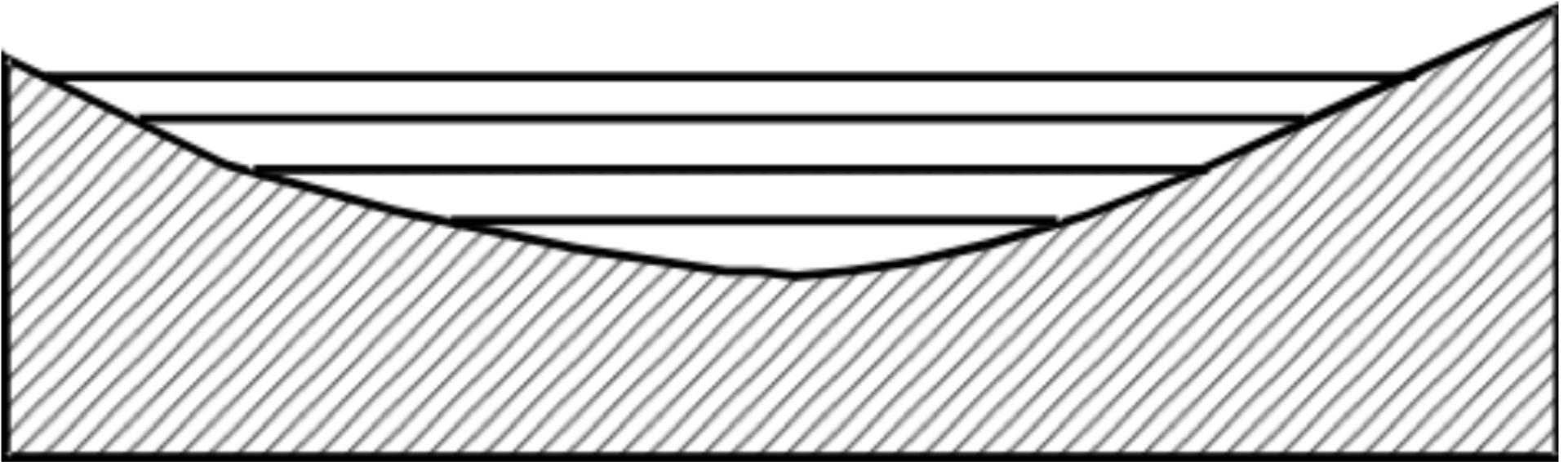
The origins of thoughts concerning the age of Earth and the possibility that it went through several transformations are found in 17th century:

- Descartes

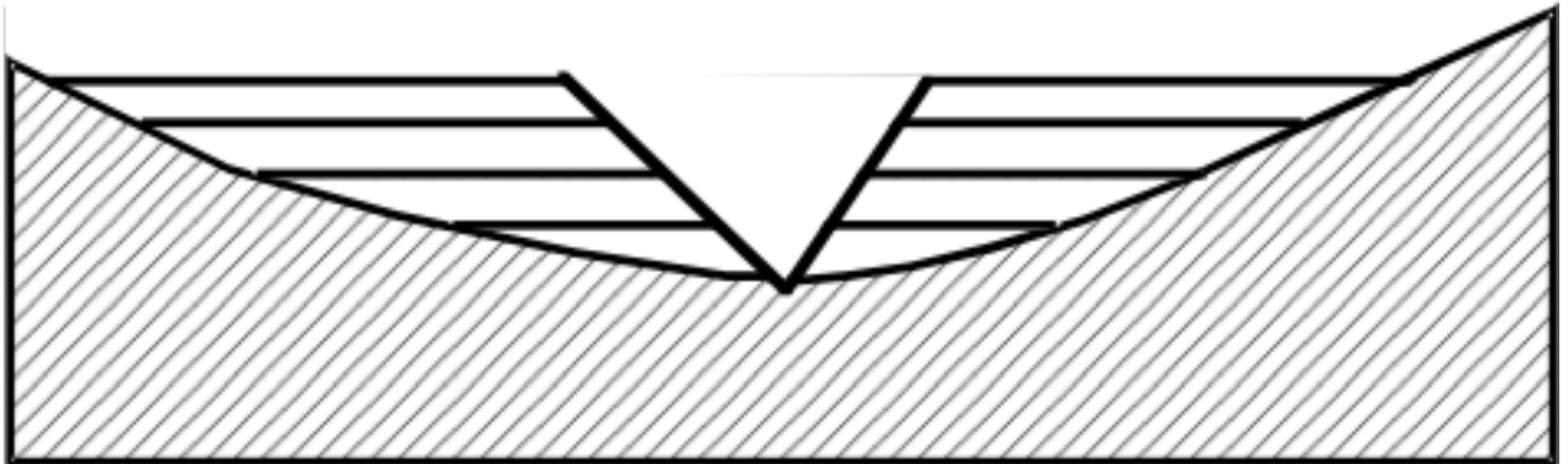
- Steno

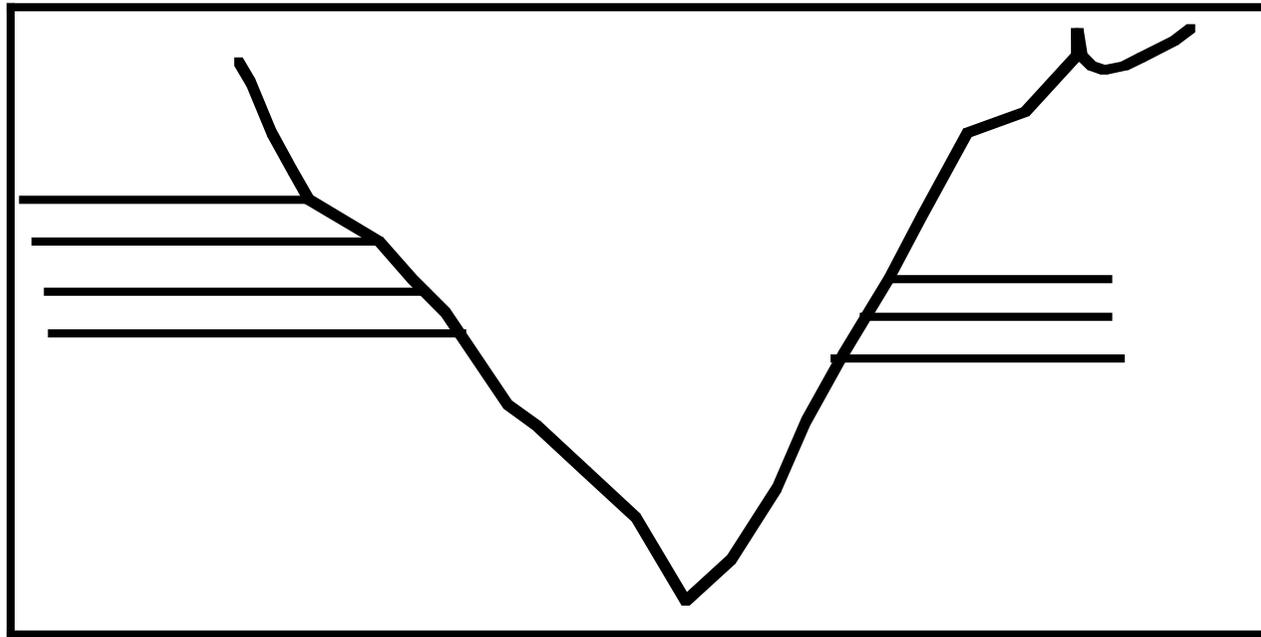
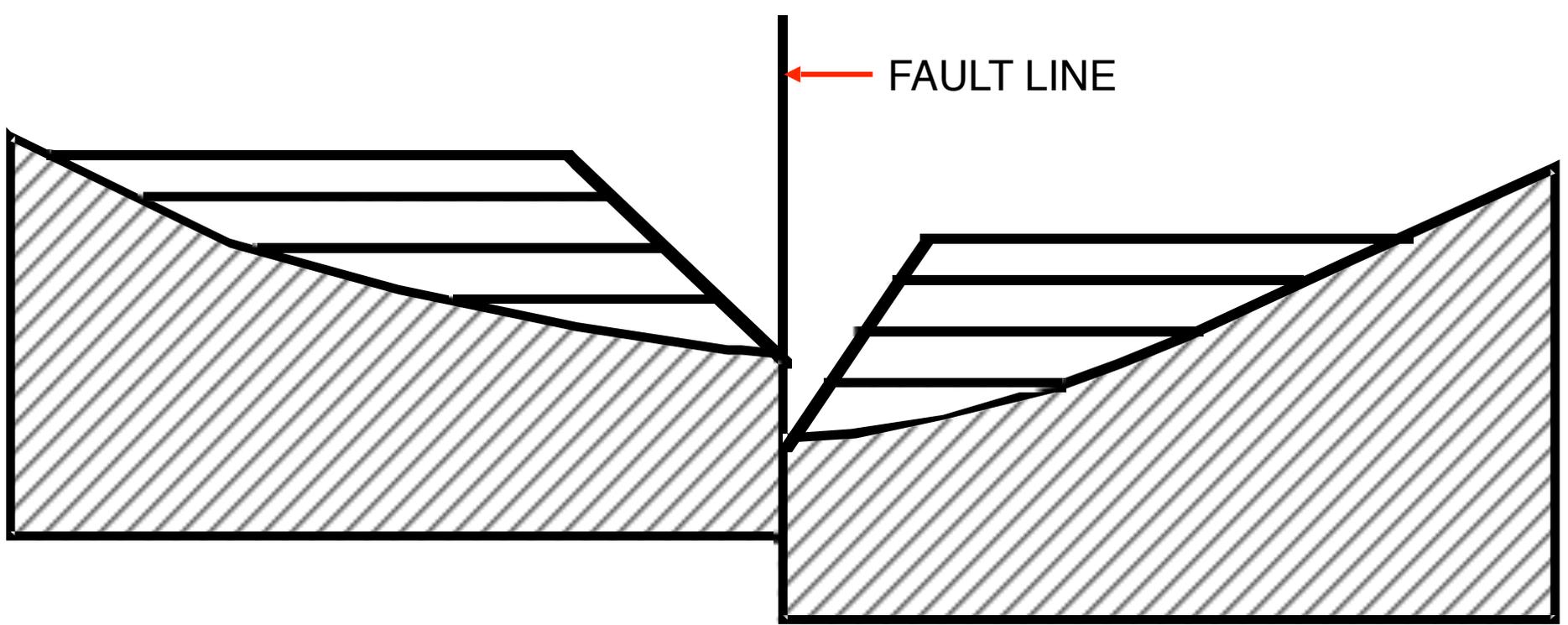


The principle of original horizontality

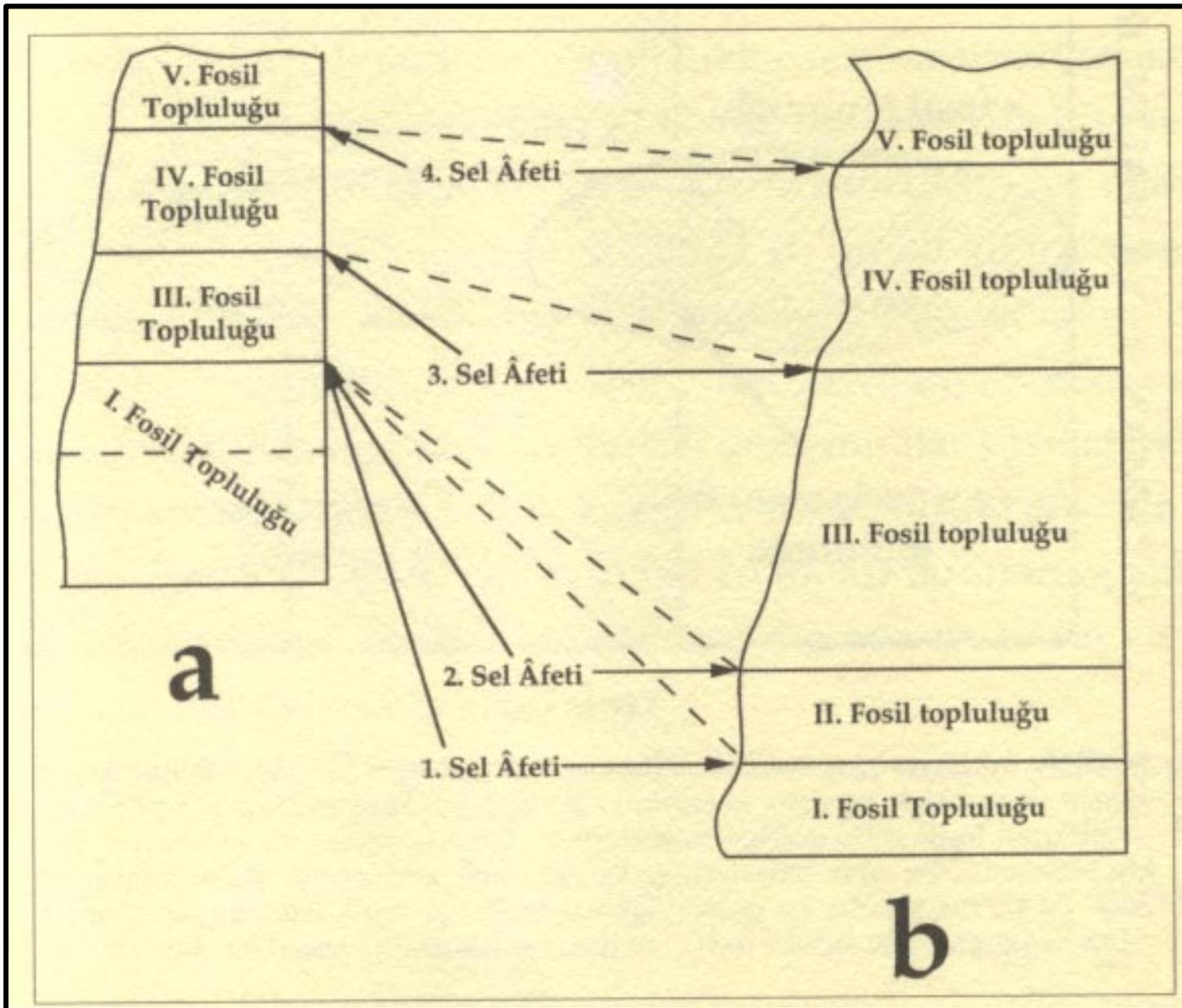


The principle of superimposition





Correlating different strata at different places is important



Correlating strata with the help of their contents, which are mainly the fossils



Georges Cuvier (1769-1832)

- ❖ Biostratigraphy is another important aspect of research concerning the natural history of Earth,
- ❖ Dating the strata and understanding the conditions in that particular stratum would be possible by studying the organisms that lived in it.

- ❖ Cuvier put forward the concept of *biohorizons*,
- ❖ Later became to be known as *Cuvier Horizons*,
- ❖ The concept states that:
- ❖ The life duration of each taxon is directly proportional to the volume of taxon,
- ❖ As the volume of taxon increases, the boundaries of taxon get larger,
- ❖ One taxon is different from another and this separation comes naturally, through time,
- ❖ This means 'extinction'.

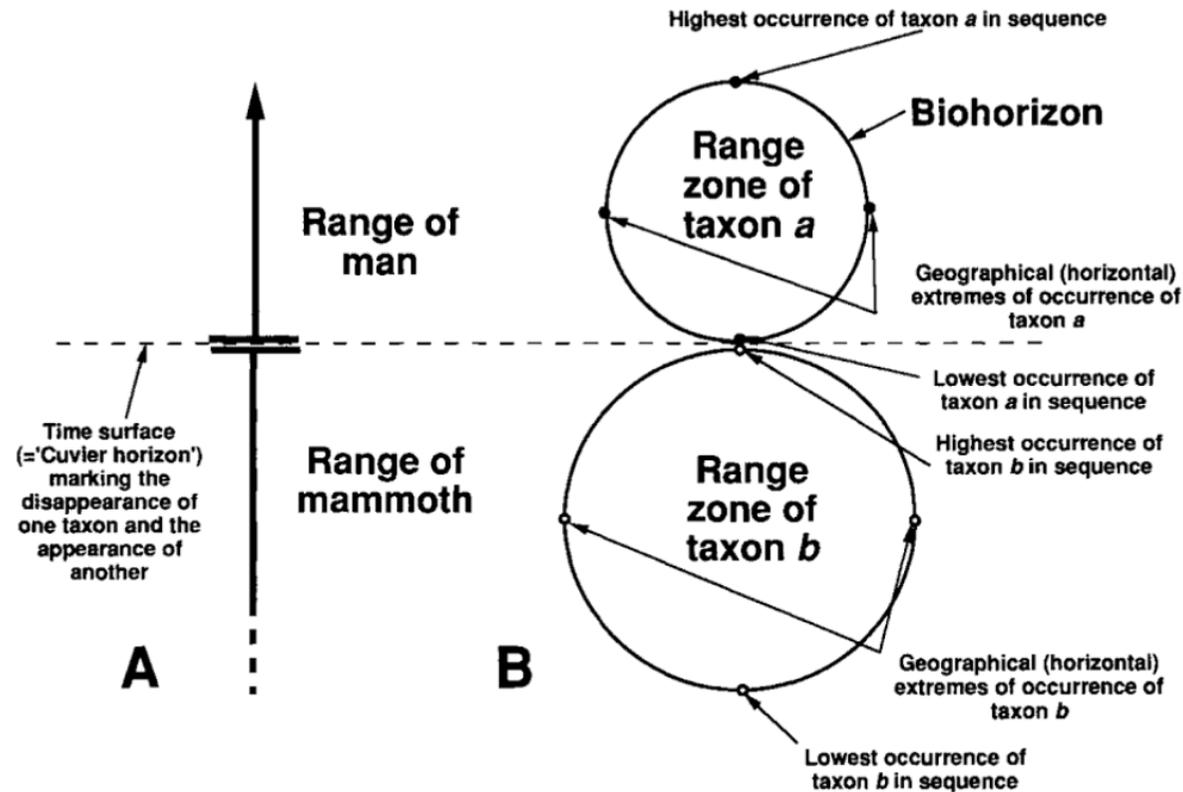
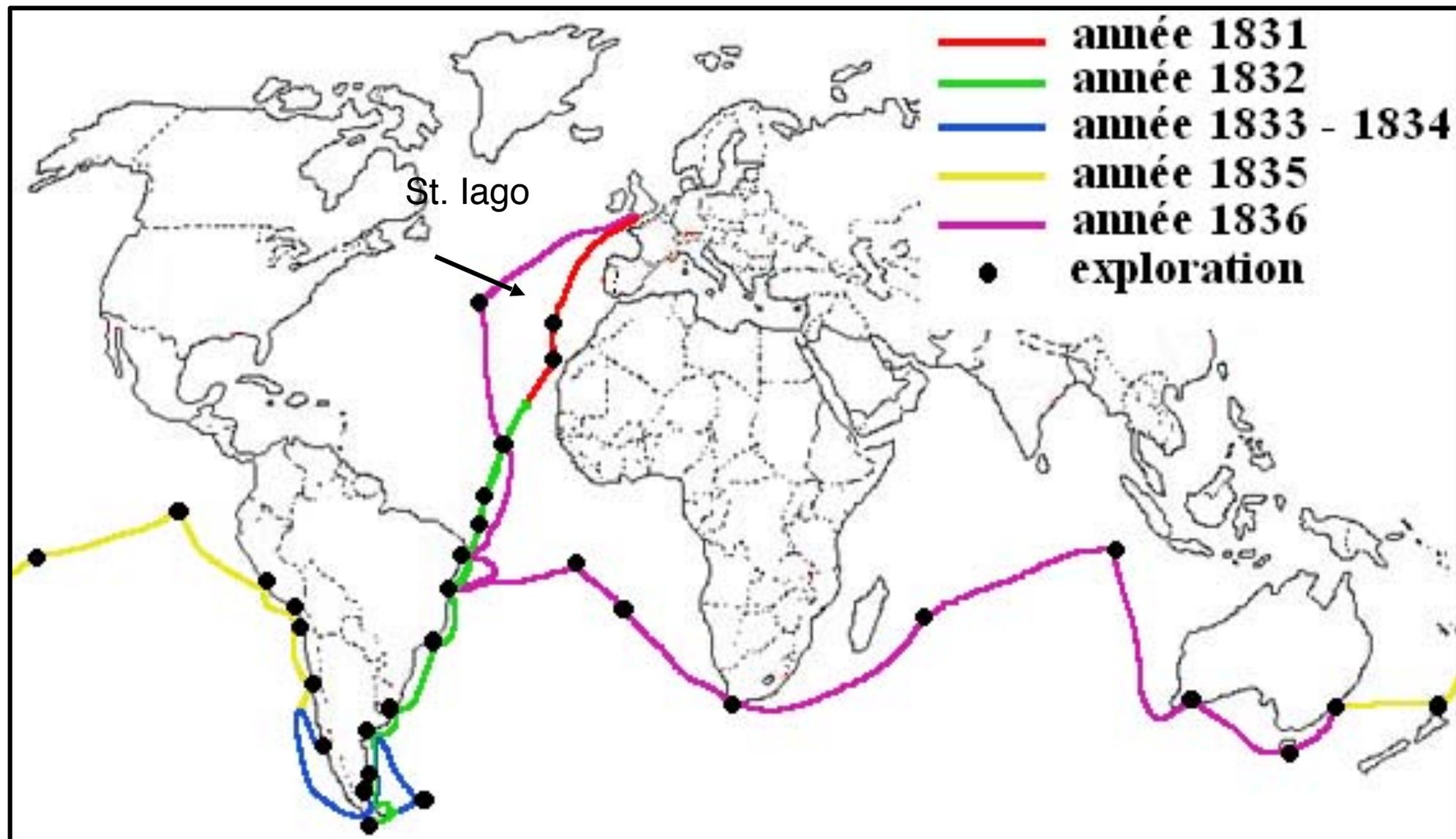


Fig. 1. A. Schematic depiction of the 'Cuvier horizon' defined herein to be that time surface separating the time of extinction of one species and the time of appearance of another. This concept is implicit in the writings of Cuvier. Cuvier thought that the fossil species he was dealing with ranged far on the surface of the earth (even globally?) and did not concern himself with their spacial limitations. Hence a one-dimensional representation suffices to represent a Cuvier horizon. B. Alexander von Humboldt, the founder of modern physical geography, criticised Cuvier's neglect of the geographical range of species and argued that, as in the case of the present-day animals and plants, the distribution of fossil organisms must also have been limited by geographical factors. This, von Humboldt thought, would make the employment of biostratigraphy much more difficult than implied in Cuvier's writings. These ideas of von Humboldt were the forerunners of the concept of *biostratigraphic zone*.

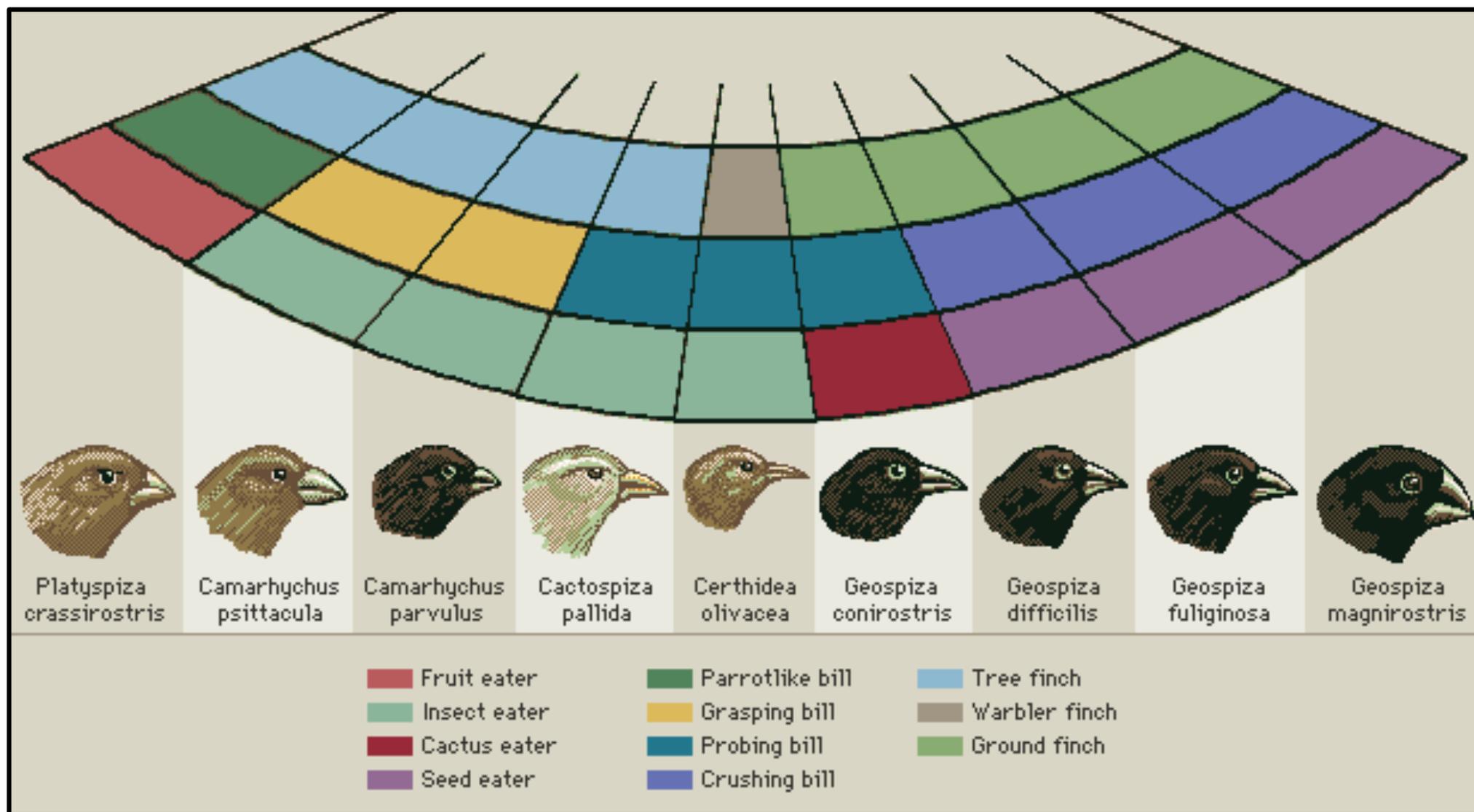
**For biostratigraphy to be useful scientifically at the
global scale;**

**it has to reflect changes in both the contents (i.e., fossils)
of strata and the geological aspects of each layer.**

**How did Darwin
develop his theory on
evolution?**



Beagle's route



The finch population at Galapagos Islands



Ground finch



Cactus finch

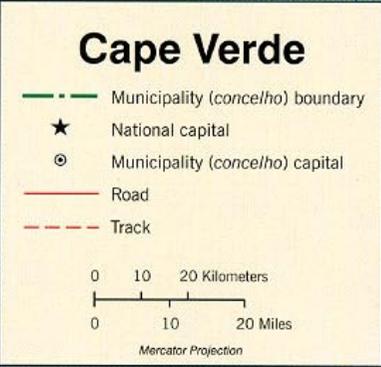
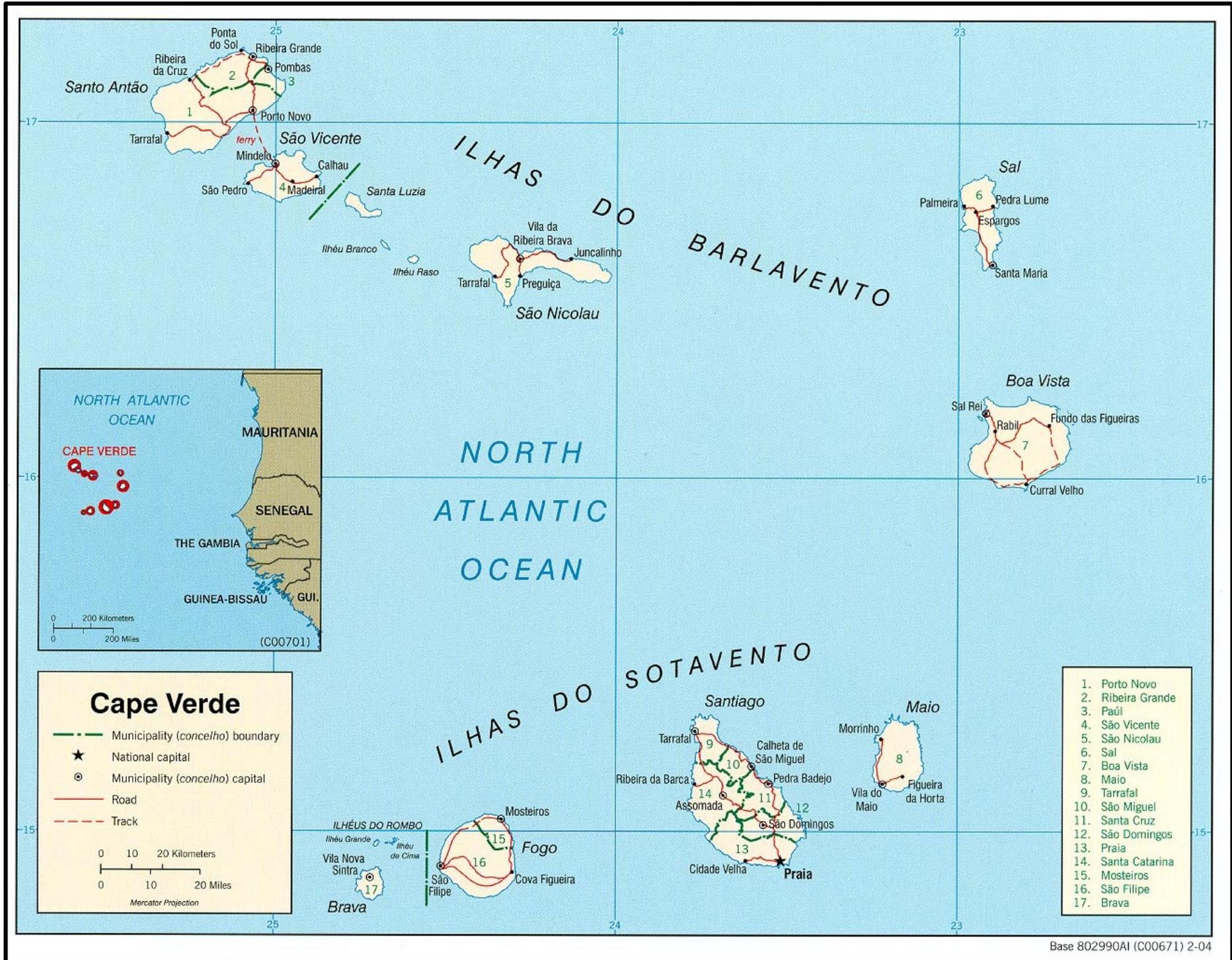


Tree finch

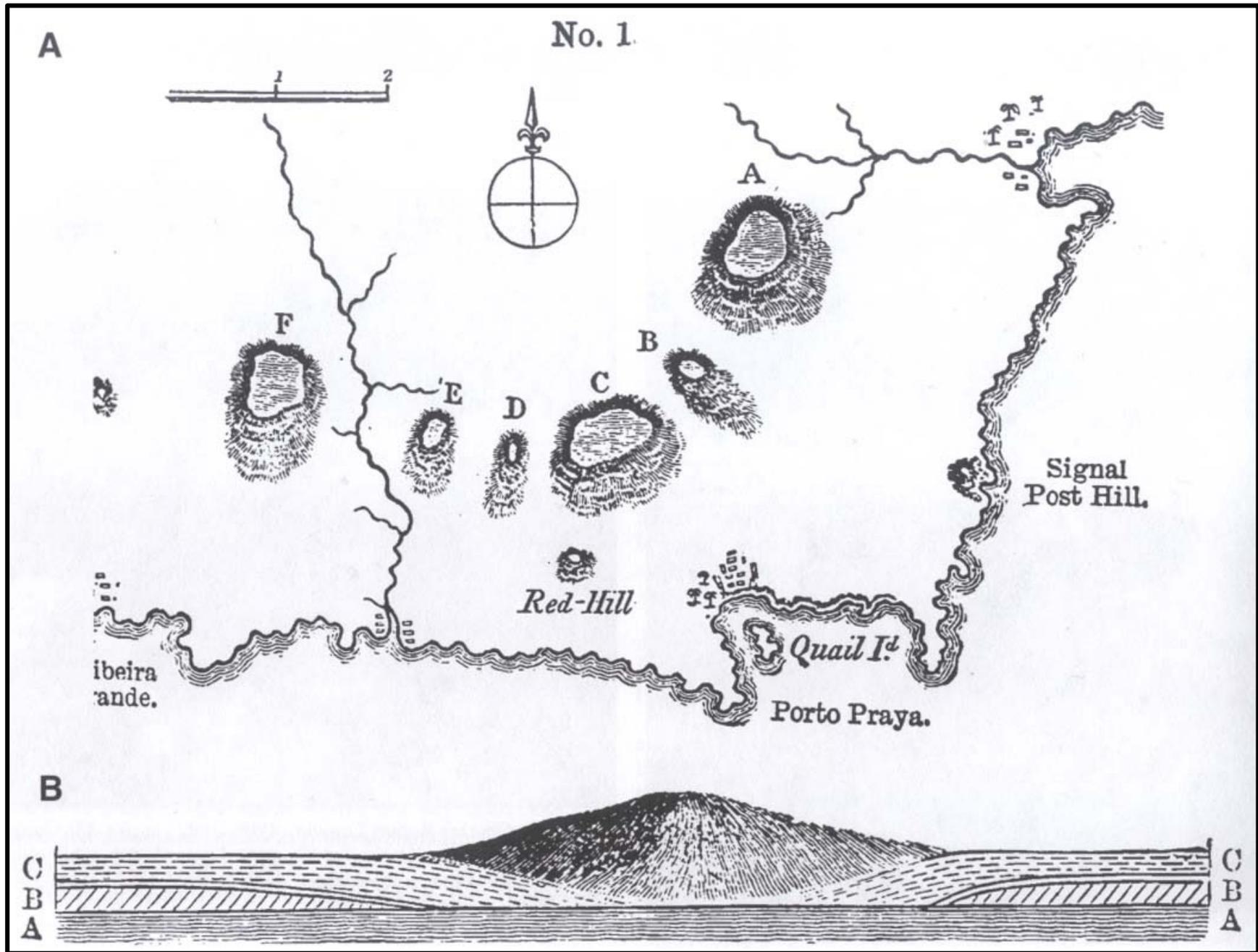


Probing finch

- ❖ Based on the genetic analyses on finches, it has been proven that finch population arrived at Galapagos Islands about 1 My,
- ❖ This group consisted of 30 individuals of ground finch (*Tiraris bicolor*) or Santa Lucia finch (*Melanospiza richardsoni*)

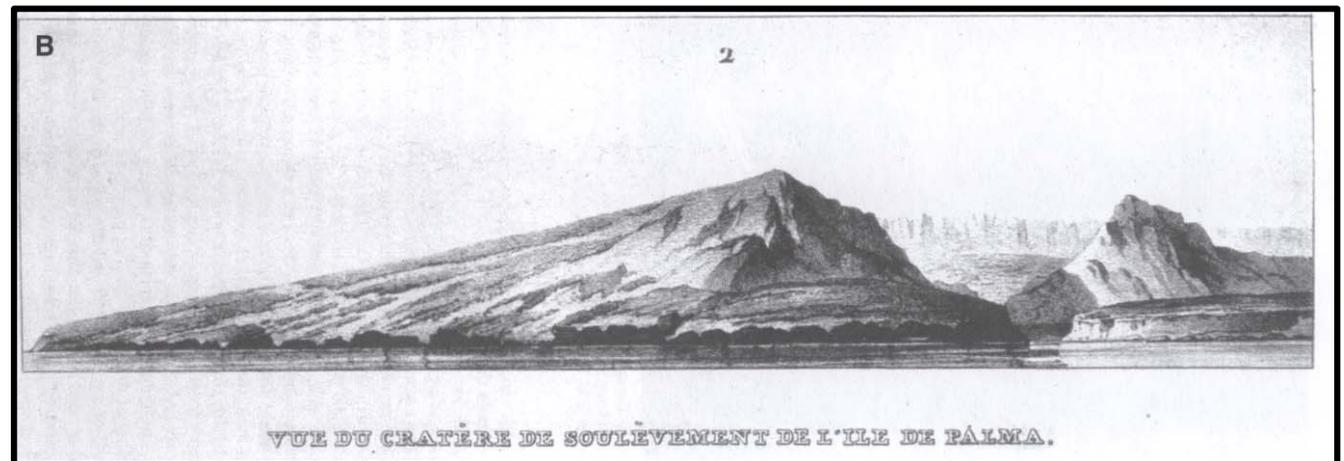
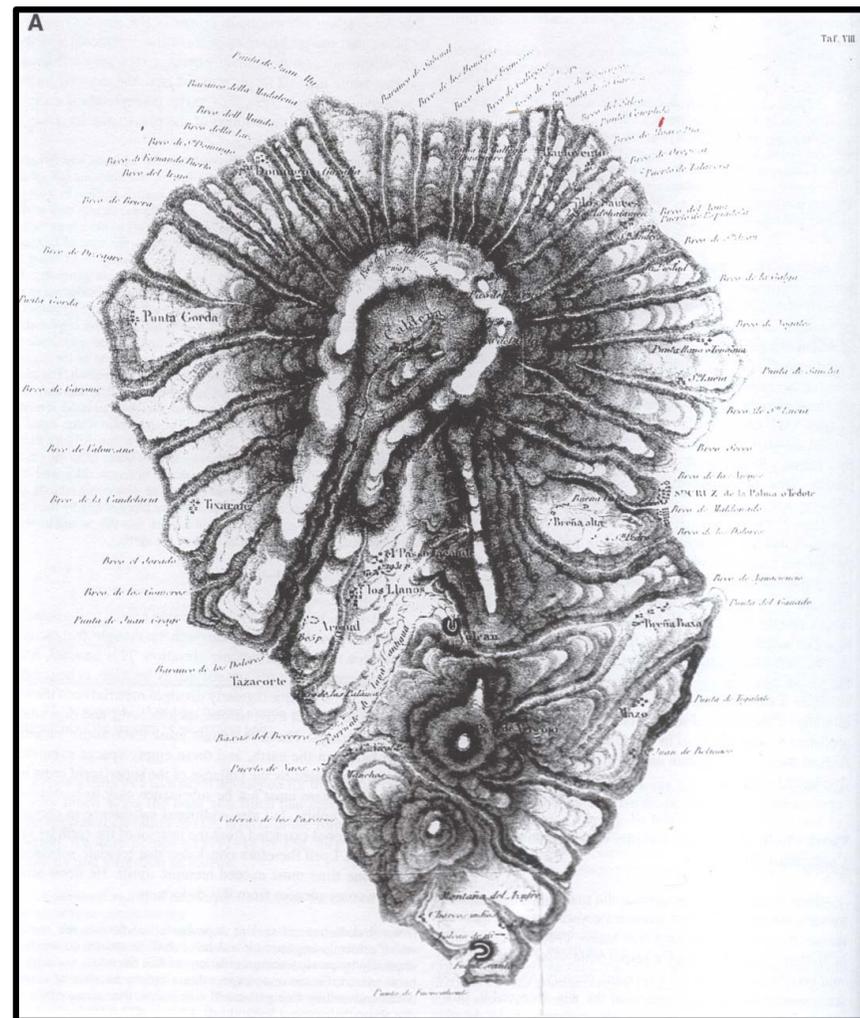


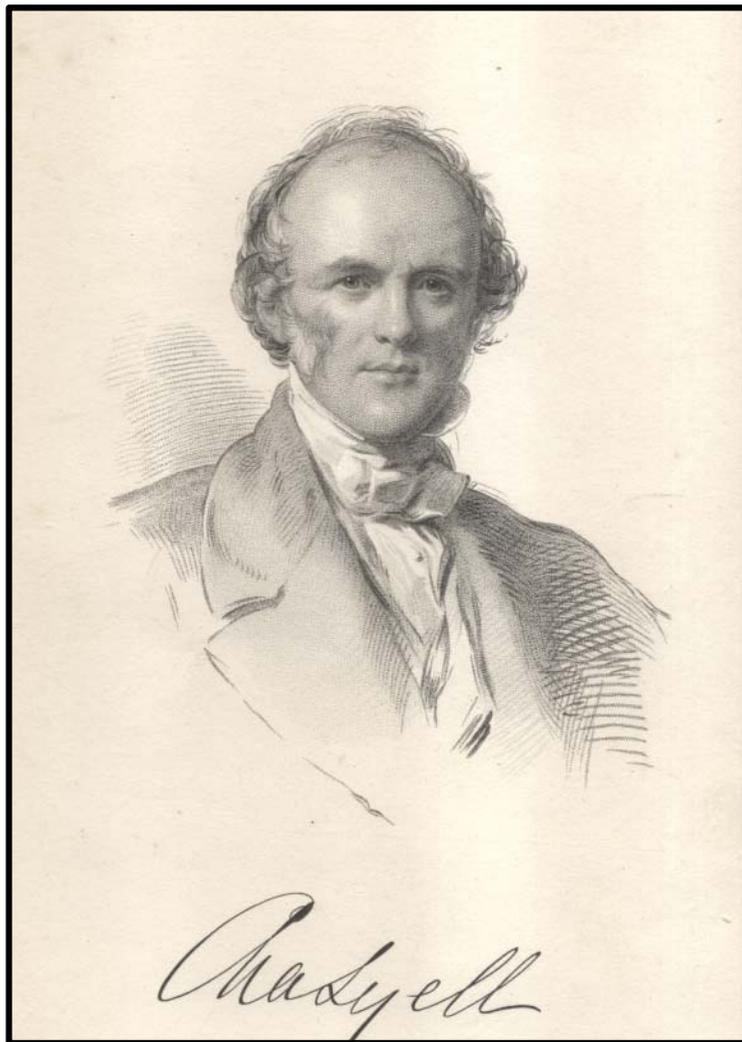
1. Porto Novo
2. Ribeira Grande
3. Paúl
4. São Vicente
5. São Nicolau
6. Sal
7. Boa Vista
8. Maio
9. Tarrafal
10. São Miguel
11. Santa Cruz
12. São Domingos
13. Praia
14. Santa Catarina
15. Mosteiros
16. São Filipe
17. Brava



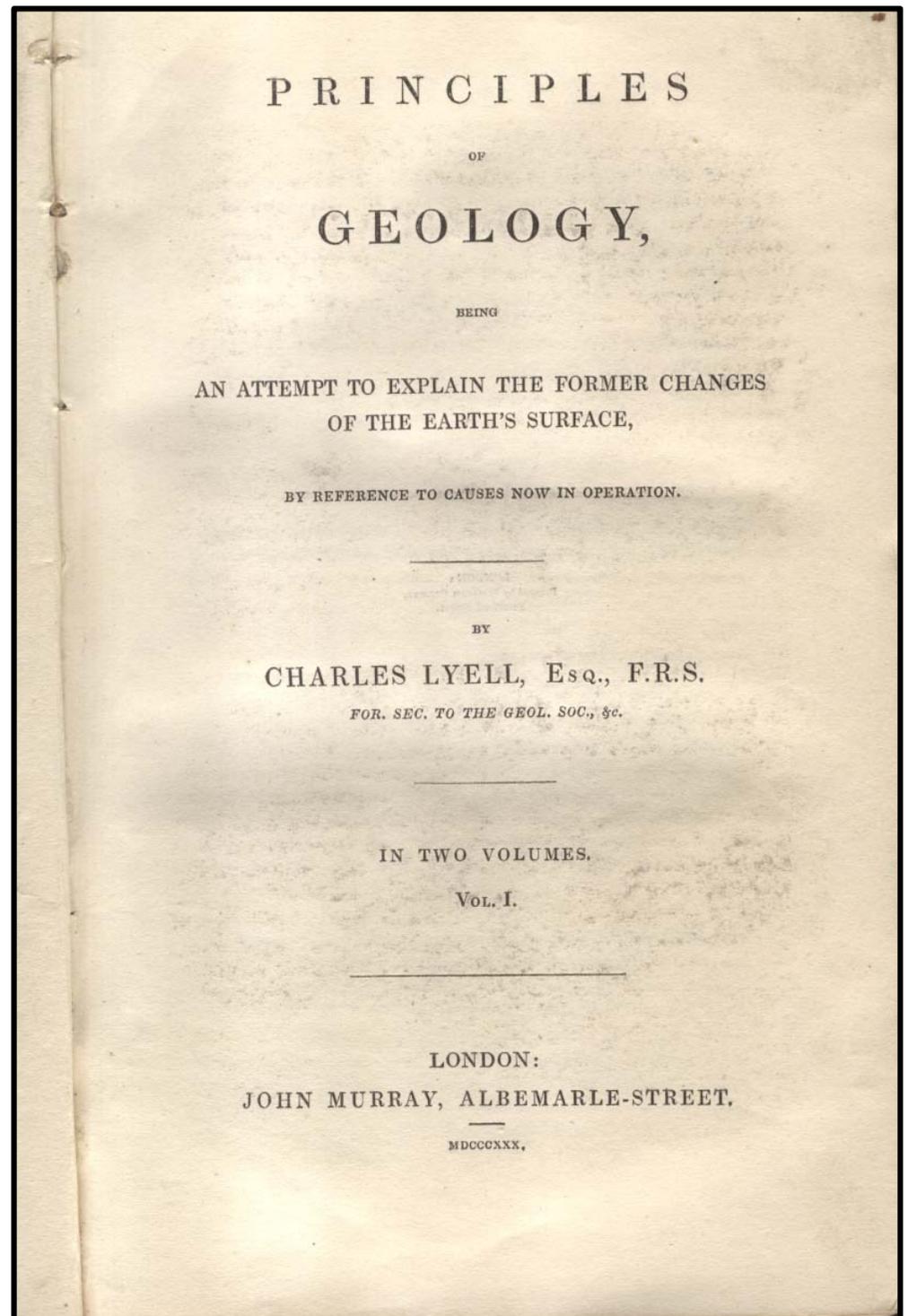
During his journey, Darwin also made some geological observations. At Cape Verde, he identified a stratum of limestone (B) being trapped by strata of volcanic layers (A and C).

His observations supported the theory of Leopold von Buch, who suggested that volcanic activity may lead to sudden up-rising. Such sudden events may be diagnosed with the help of “up-lift craters” as seen on St. Iago island.



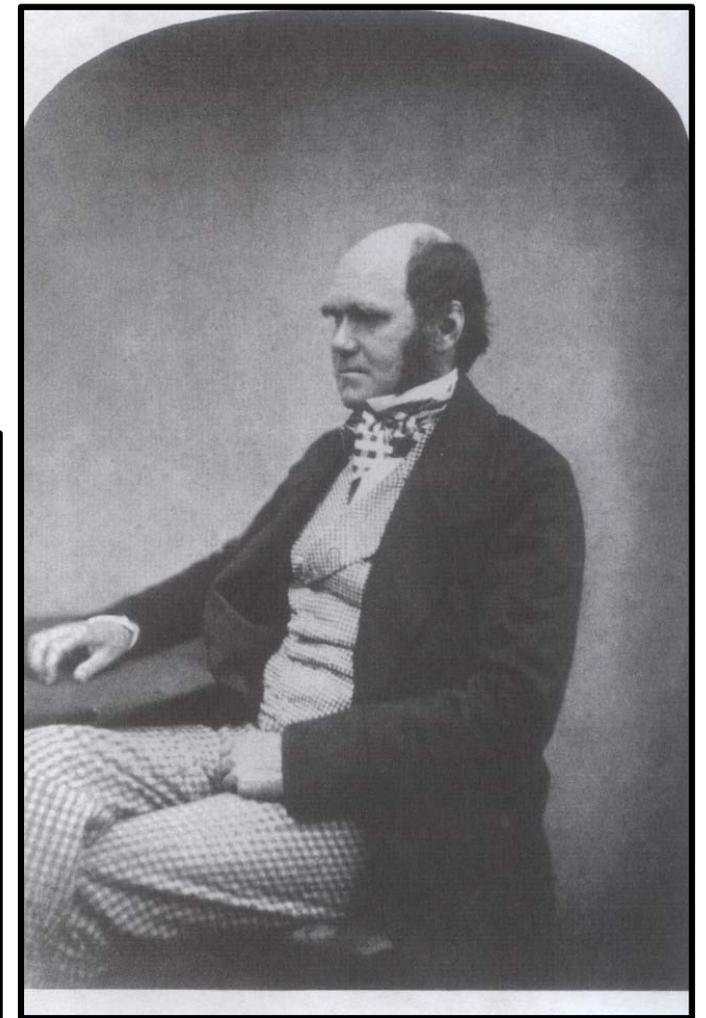
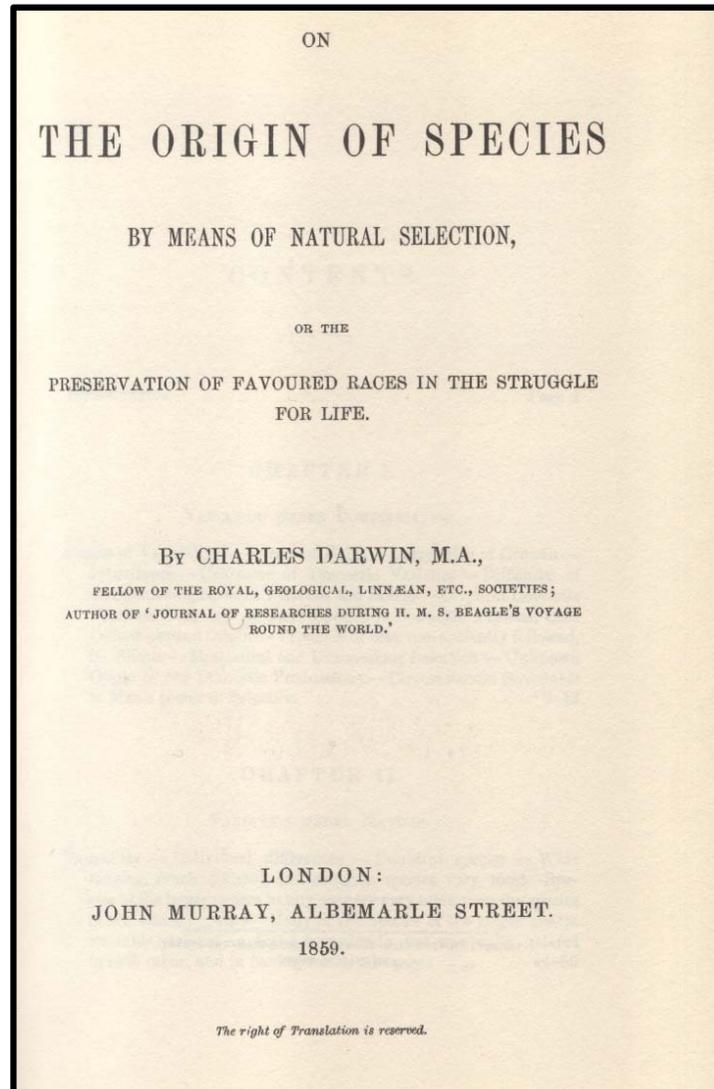


Sir Charles Lyell
(1798-1875)



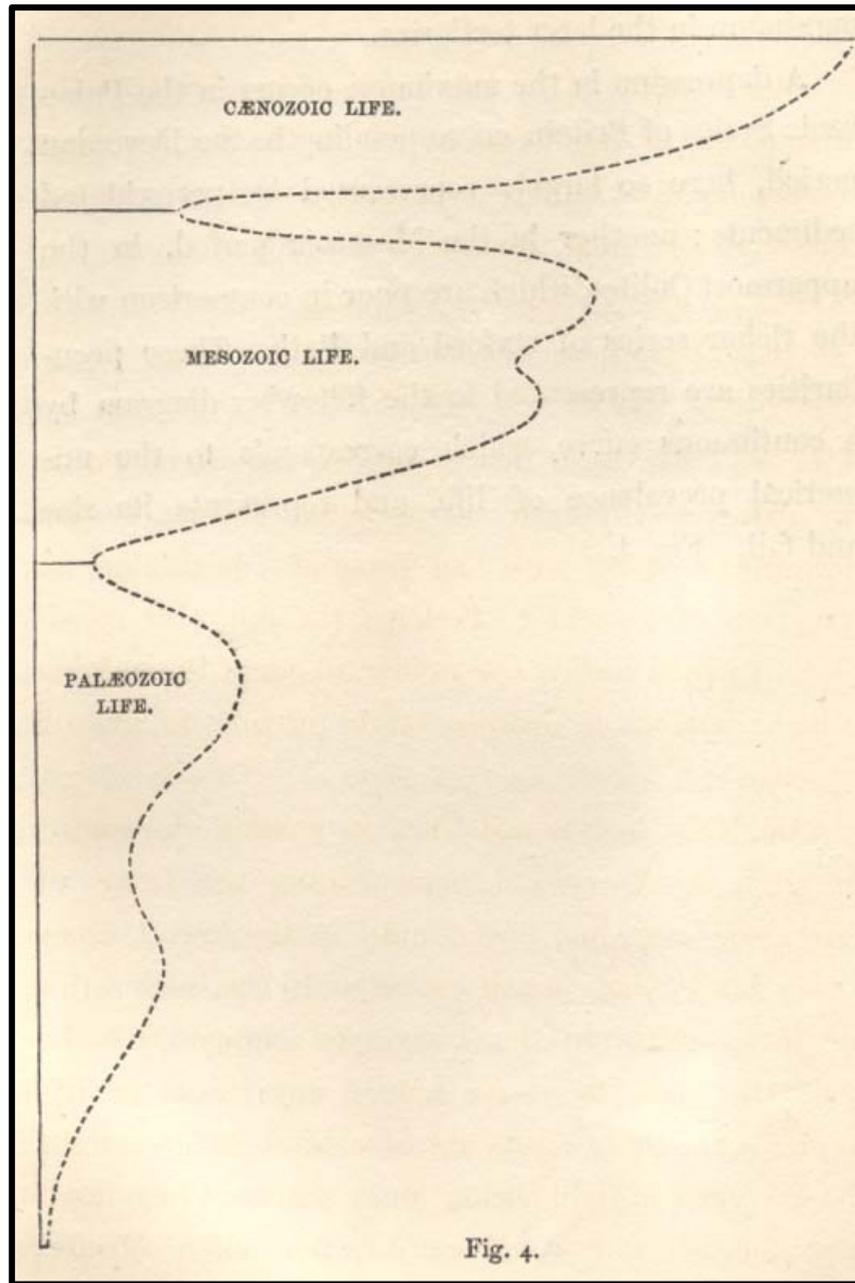


Alfred Russel Wallace (1823-1913) discovered the natural selection as the evolutionary mechanism (1857)

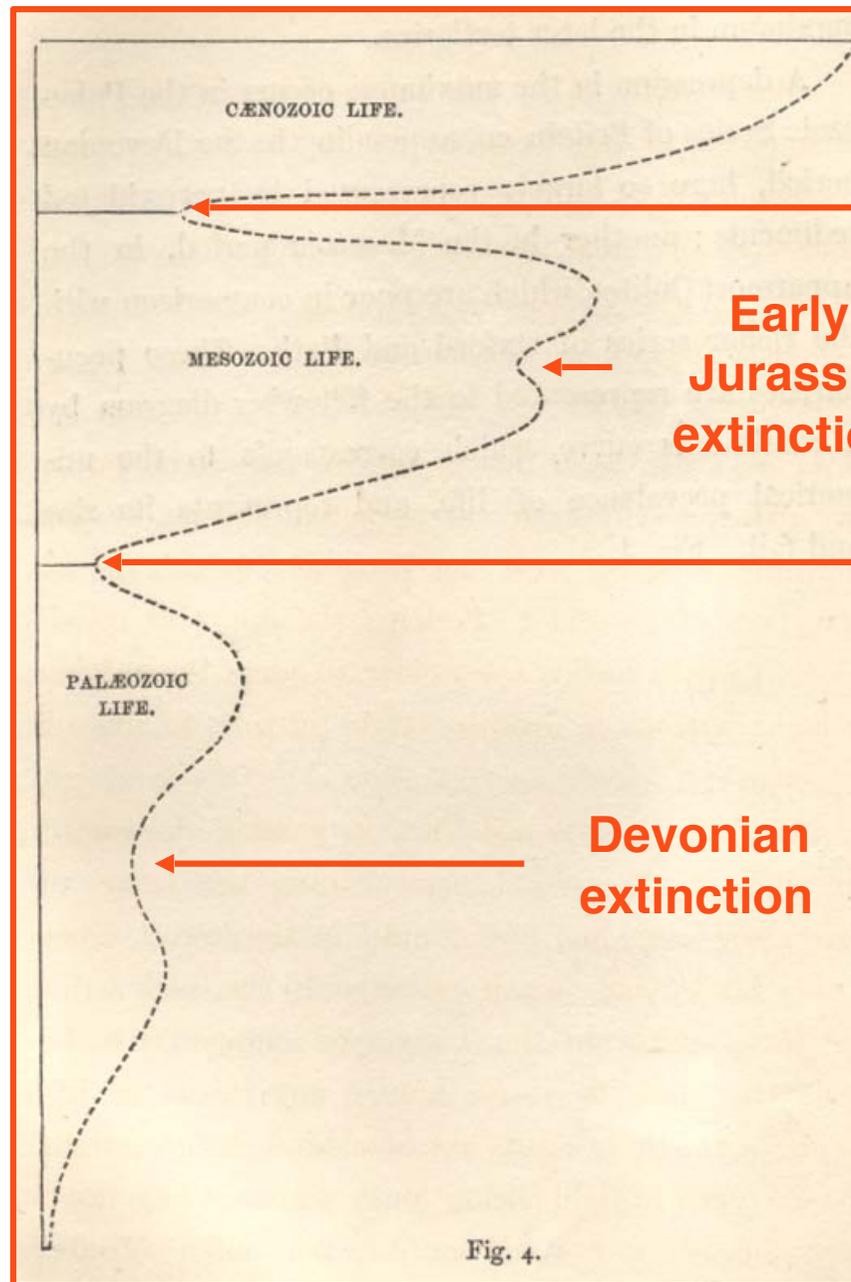


Charles Darwin (1809-1882) published his book (1861).

- ❖ **It was widely accepted that if Darwin and Wallace had been completely right about evolution, biostratigraphy would have been impossible to explain,**
- ❖ **Because, observations revealed that in some of these strata there were big gaps that did not contain fossil evidence. Before Darwin, scientists failed to interpret these gaps accurately,**
- ❖ **However, Darwin argued that such gaps in geological strata might have been caused by sudden changes (e.g. Volcanism, tectonics, flooding, etc.), which also caused changes in organisms.**



John Phillips's *Life on the Earth* (1860) showing the divisions of Paleozoic, Mesozoic, and Cenozoic periods. During each transition, major extinctions were observed, which still hold true.

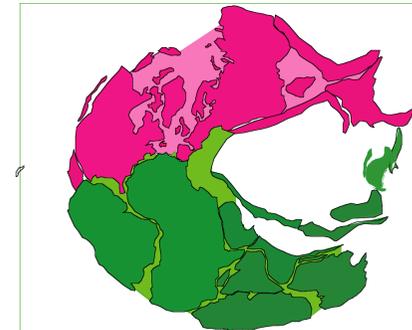


Chixulub

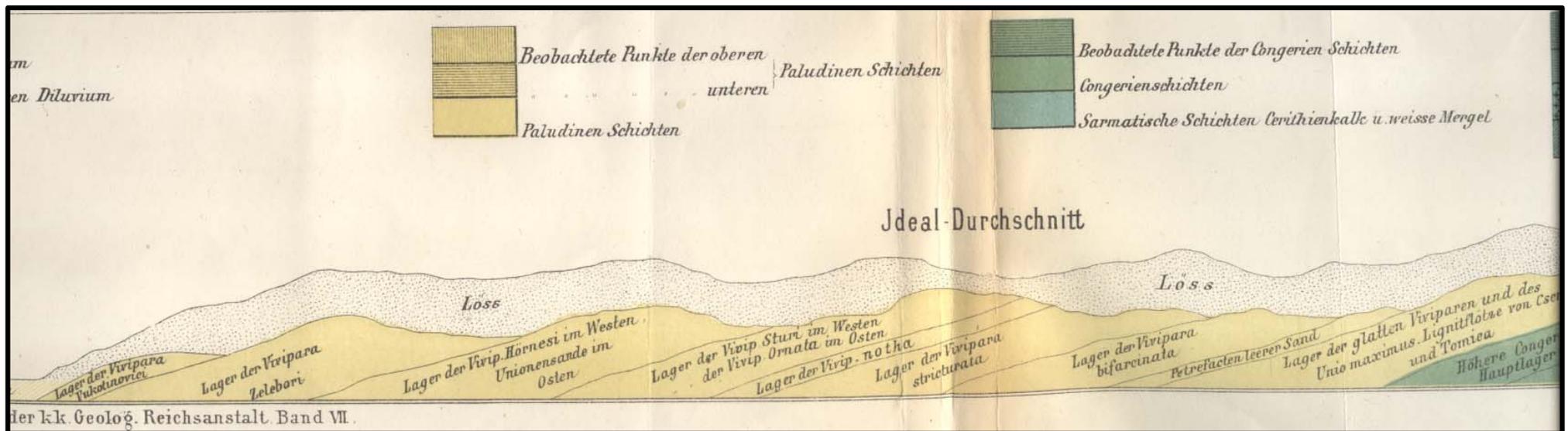


Early Jurassic extinction

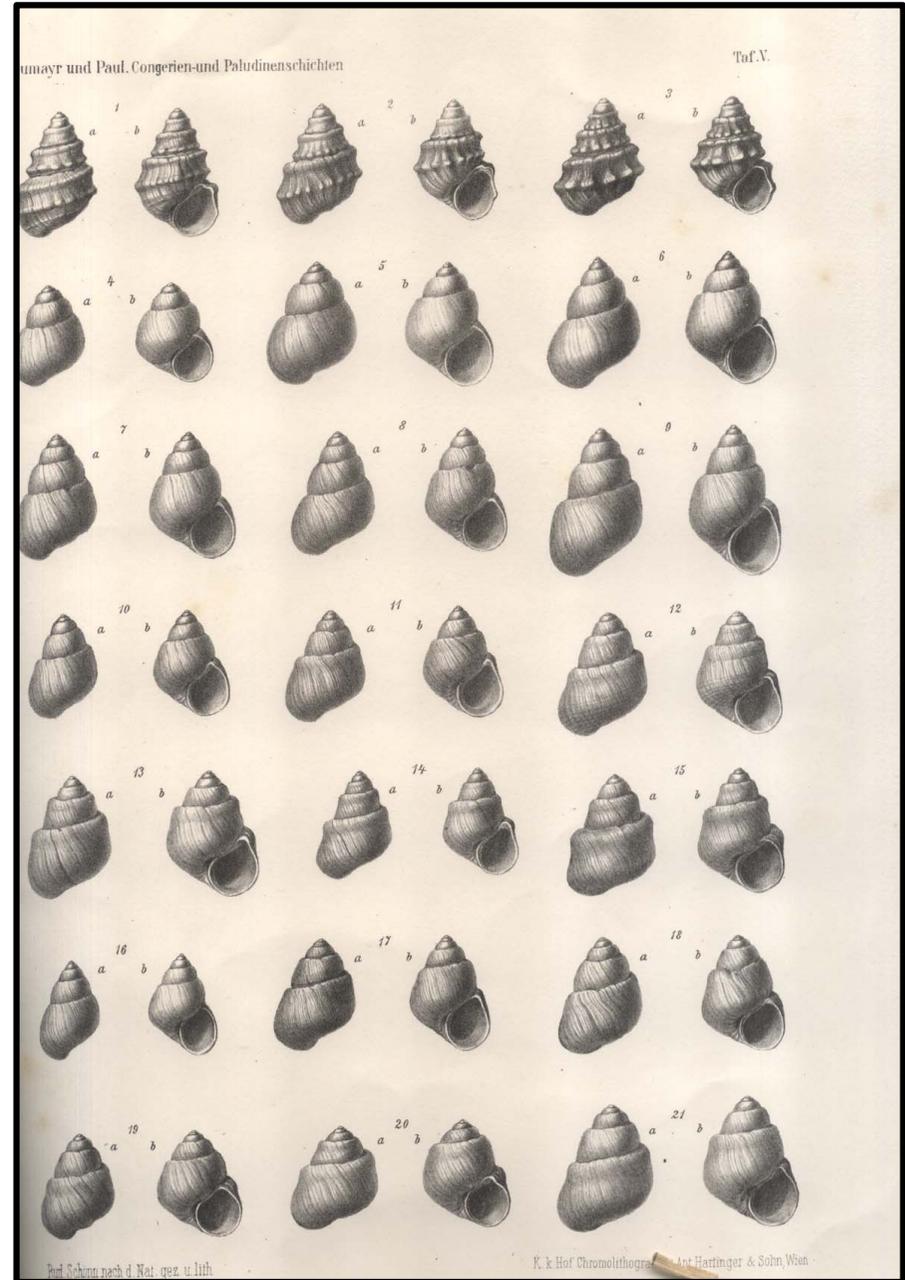
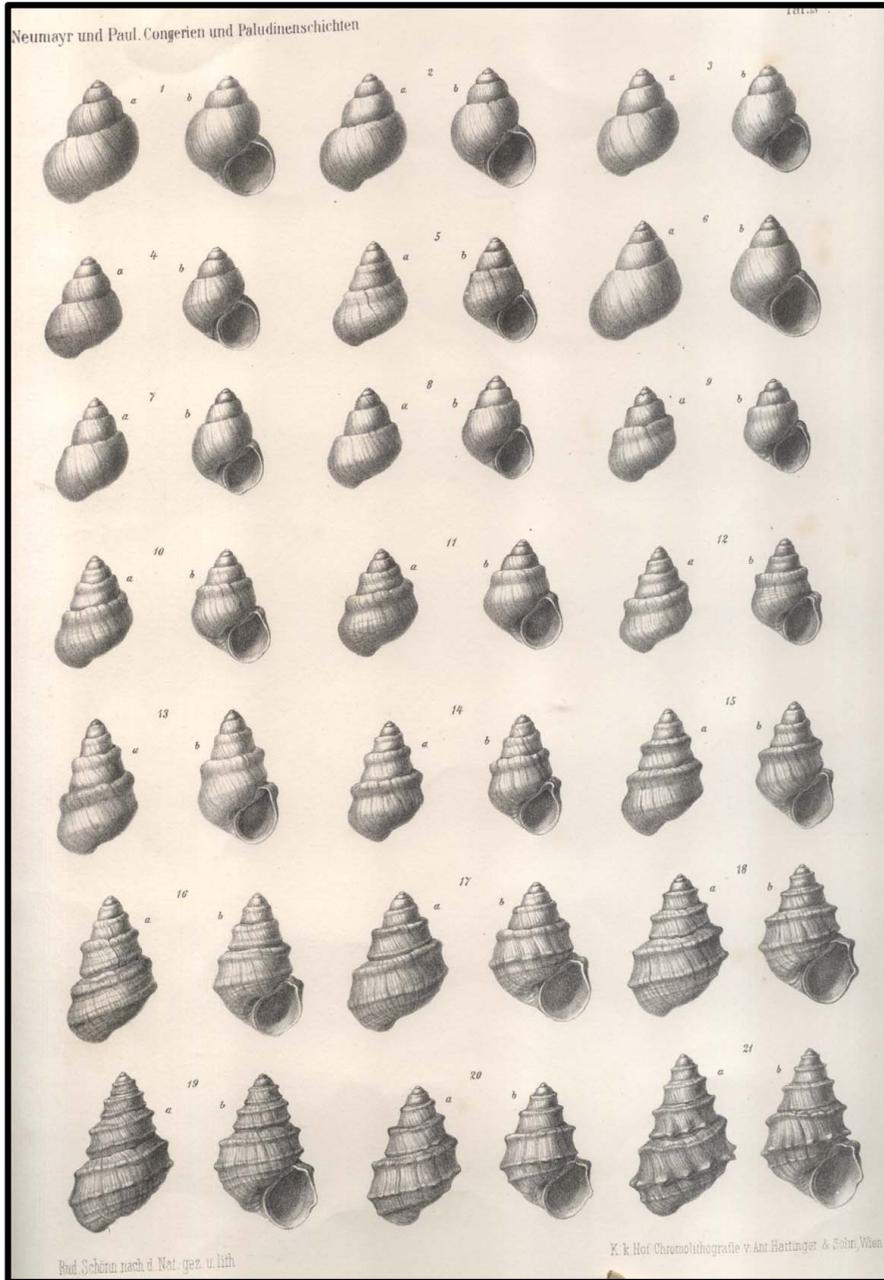
Changes in continents



Devonian extinction



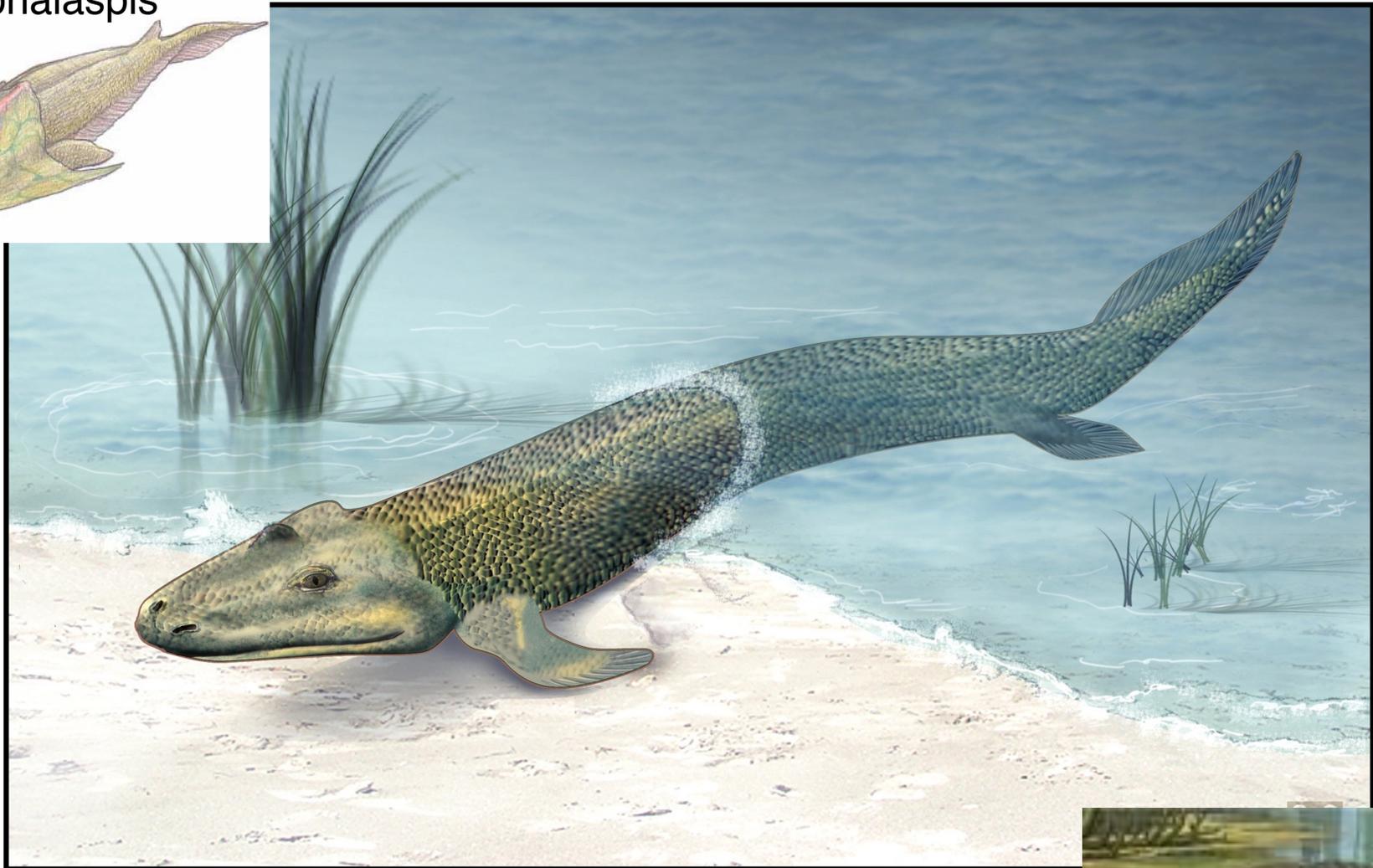
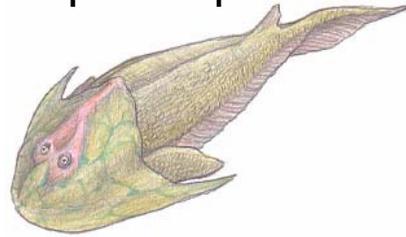
- ❖ Newmayr and Paul's research revealed the evolutionary sequence of Vivipara (sea shells),
- ❖ Geological research has proven how widespread and diverse the body of evidence for continuity was, as early as 19th century.



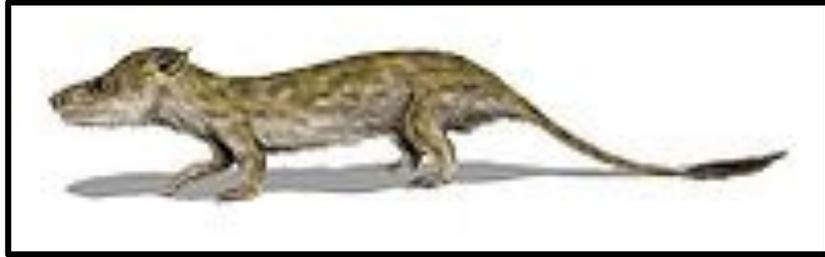
Some of the *Vivipara* species studied by Neumayr and Paul

Continuous evolution and species that existed in-between have also been documented in vertebrates as well. *Tiktaalik roseae* a species between fish-amphibeian (375 My).

Cephalaspis



Ichthyostega



Oligokyphus

Triassic-early Jurassic

“reptile”



Mustela

Modern

“mammalian”



THERAPSIDA

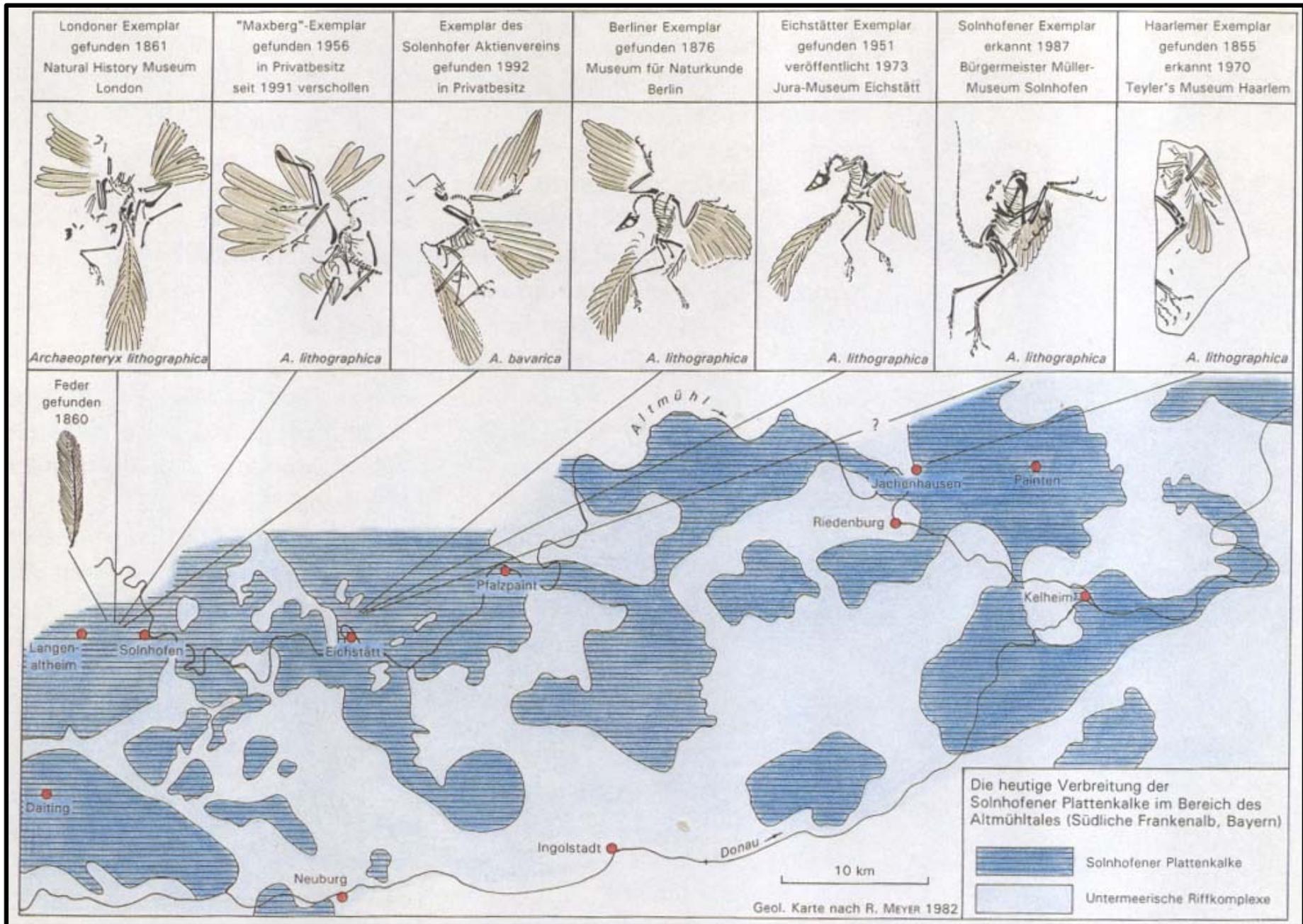
However, the most striking discovery concerning the evolutionary transition has been from reptiles to avians.



A fossilized feather
found in 1860's



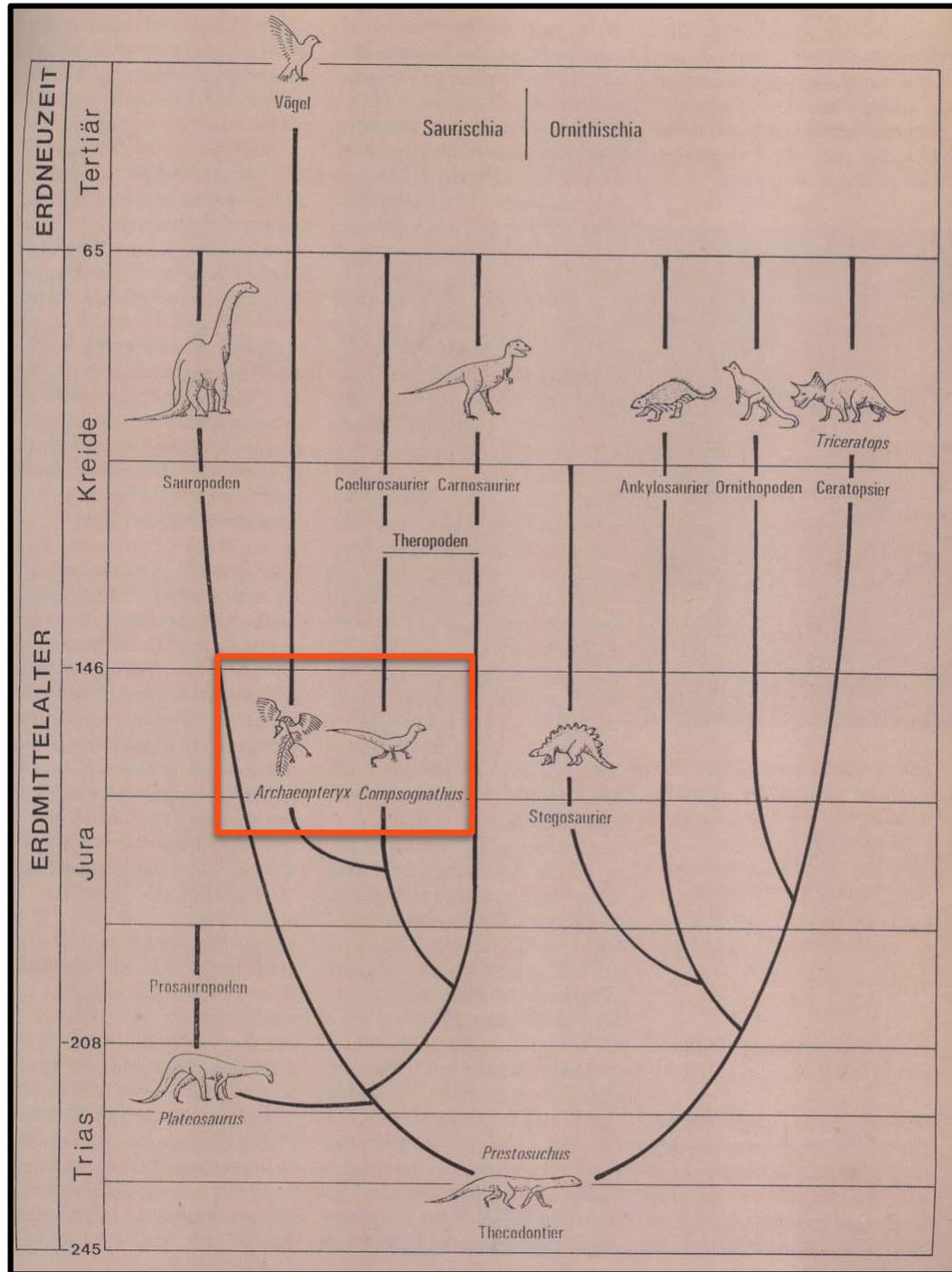
Archaeopteryx lithographica von
MEYER (1861) in London

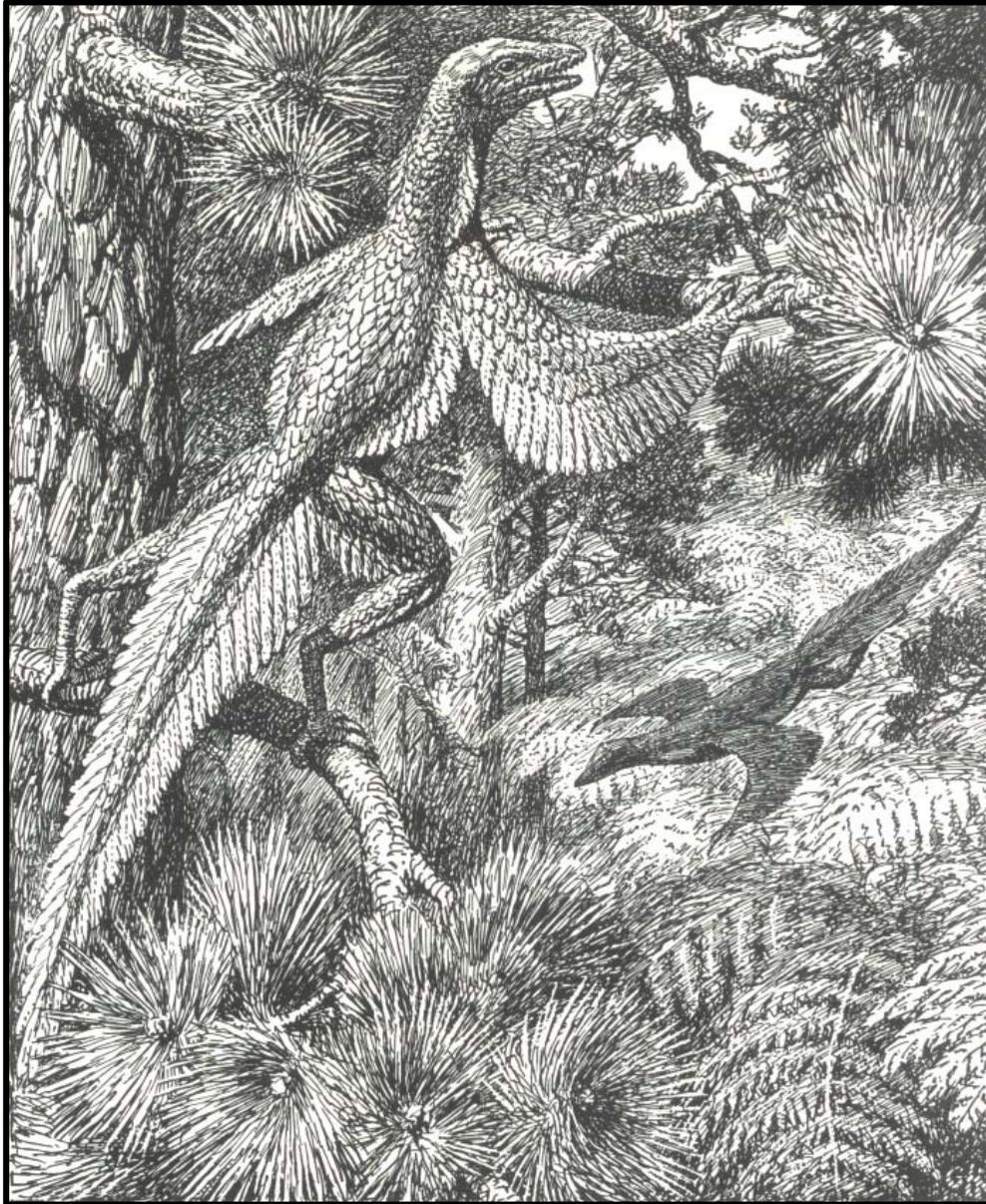


Archaeopteryx fossils found until 1955



Compsognathus longipes





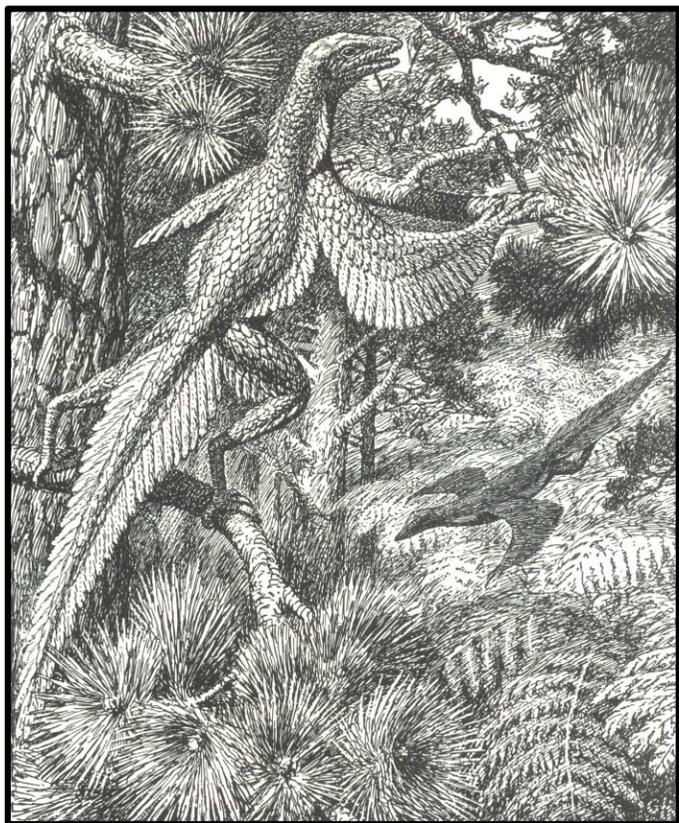
The research of Beebe (1915) and Steiner (1917) inspired G. Heilmann (1927) to illustrate an in-between species.

This Proavis was illustrated as Tetrapteryx and it was defined on the basis of evolutionary traits

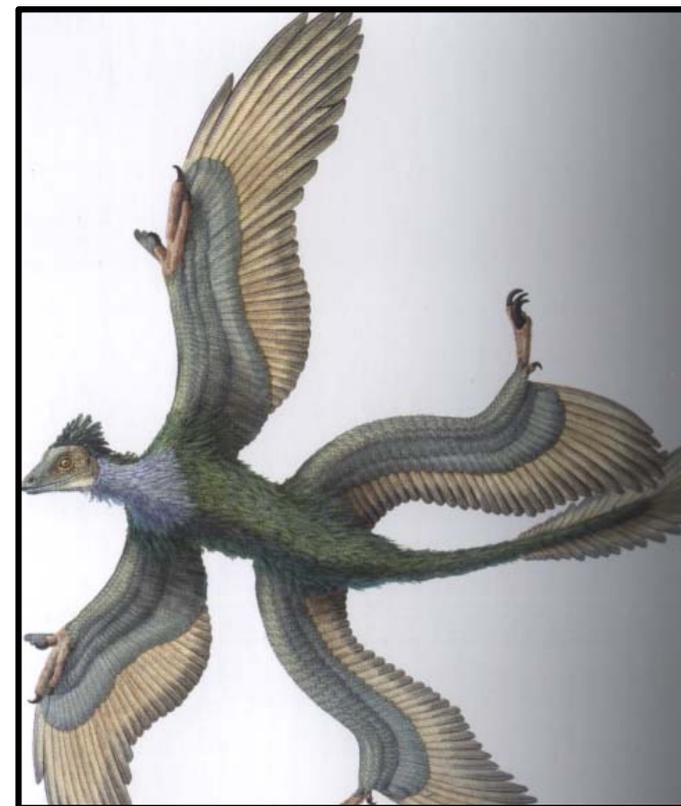


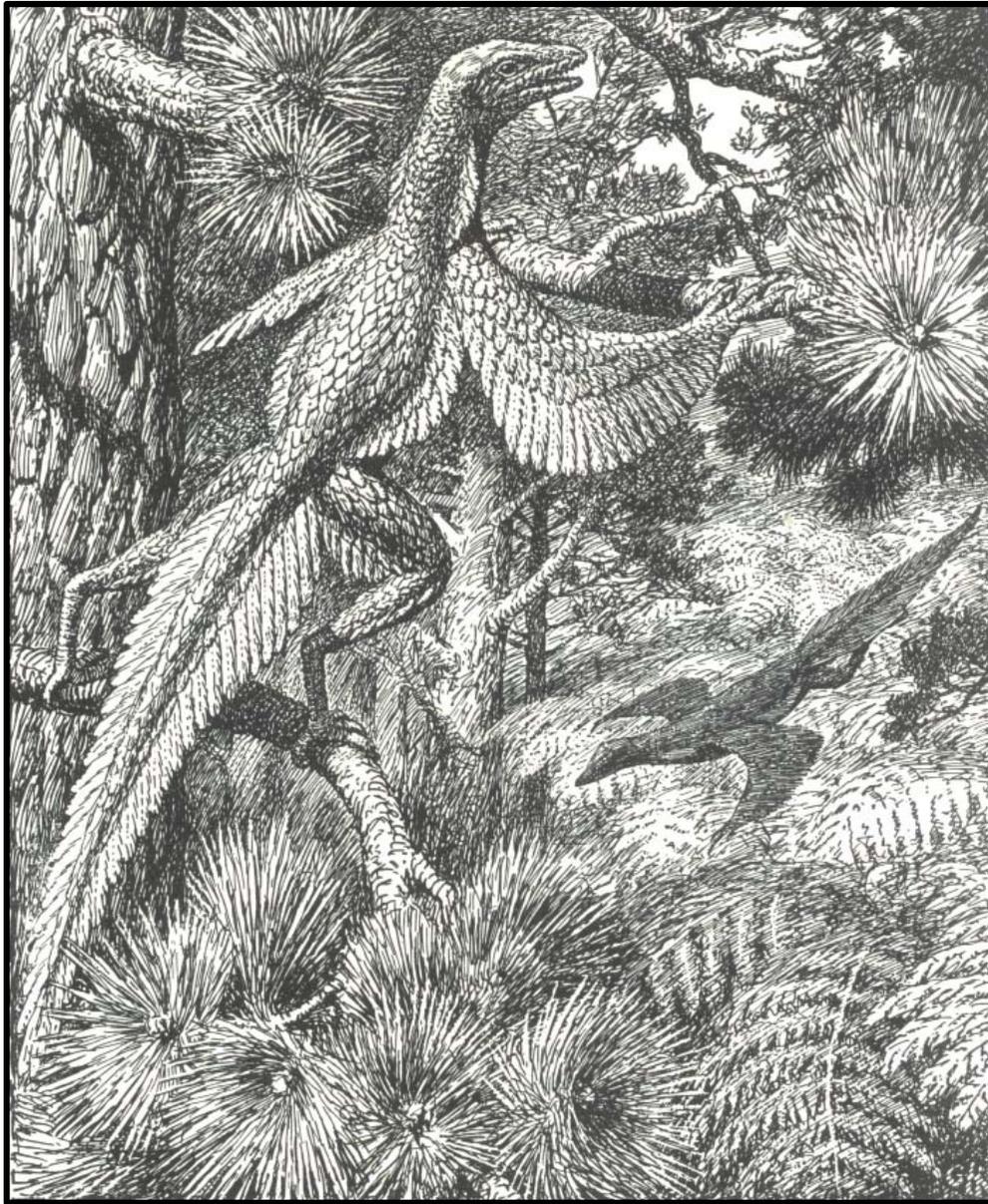
Microraptor gui

Fossil found at Liaoning in 1990's



Microraptor gui
reconstruction and
comparison with
Proavis.





Presumed....



Actual discovery in September of
2009...