



LIVING FOSSILS

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WHAT IS A LIVING FOSSIL?



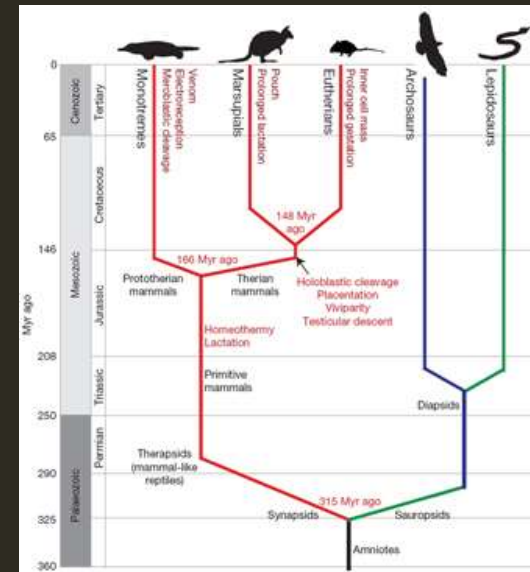
Steropodon,
100 MYA

The term “living fossil” is from Darwin’s *On the Origin of Species* (1859): “These anomalous forms may almost be called living fossils; they have endured to the present day, from having inhabited a confined area, and from having thus been exposed to less severe competition.” He is referring to living species that physically resemble organisms that are found in the fossil record, such as the platypus.

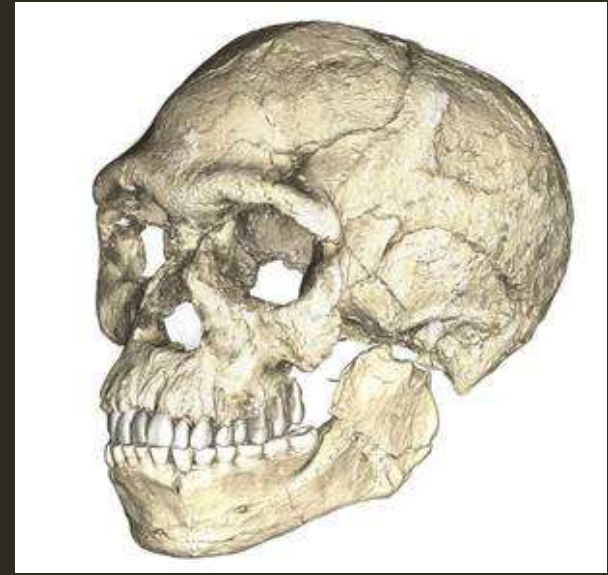
From Nature.com

In the conclusion of his book he wrote: “Species and groups of species which are called aberrant, and which may fancifully be called living fossils, will aid us in forming a picture of the ancient forms of life.”

“Living fossil” is a term that gets used a lot, and often inaccurately.



WHAT CAN WE CALL A LIVING FOSSIL?

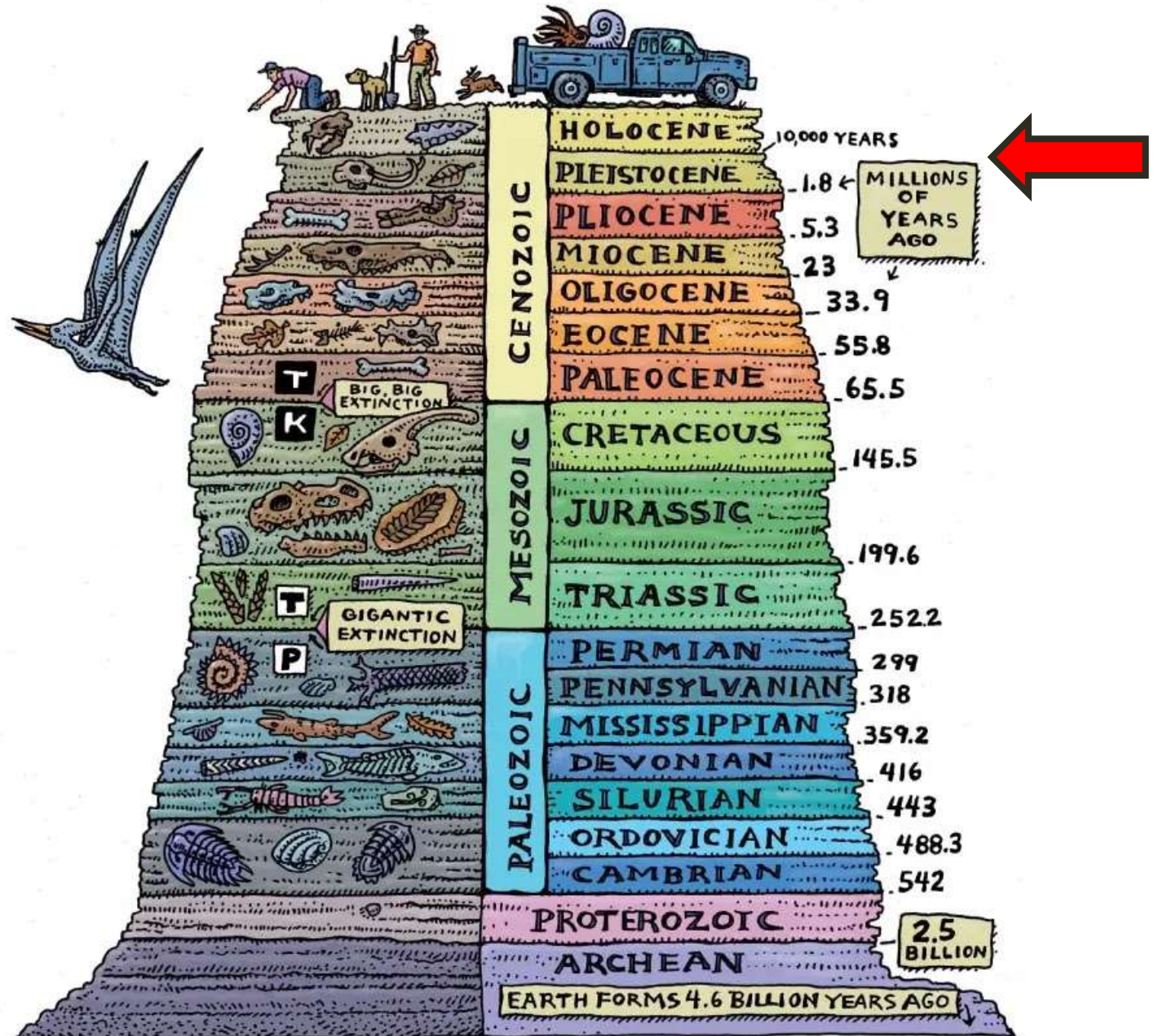


This is the fossil of a human skull found in Morocco, dated to roughly 300,000 years ago.

Fossils can form in as little as 10,000 years. It takes more than a resemblance to fossilized remains to qualify as a “living fossil.”

Otherwise the term is meaningless because any extant lifeform that has any fossil record is a “living fossil”, including us.

TIMELINE



NO LIVING SPECIES WAS DINOSAUR FOOD



The most common error I see with the term “living fossil” is the idea that living (extant) species were around during the time of the dinosaurs (Mesozoic Era, 245 to 66 MYA).

Organisms are constantly evolving. There is no way that a living species today is exactly the same as something that lived so long ago.

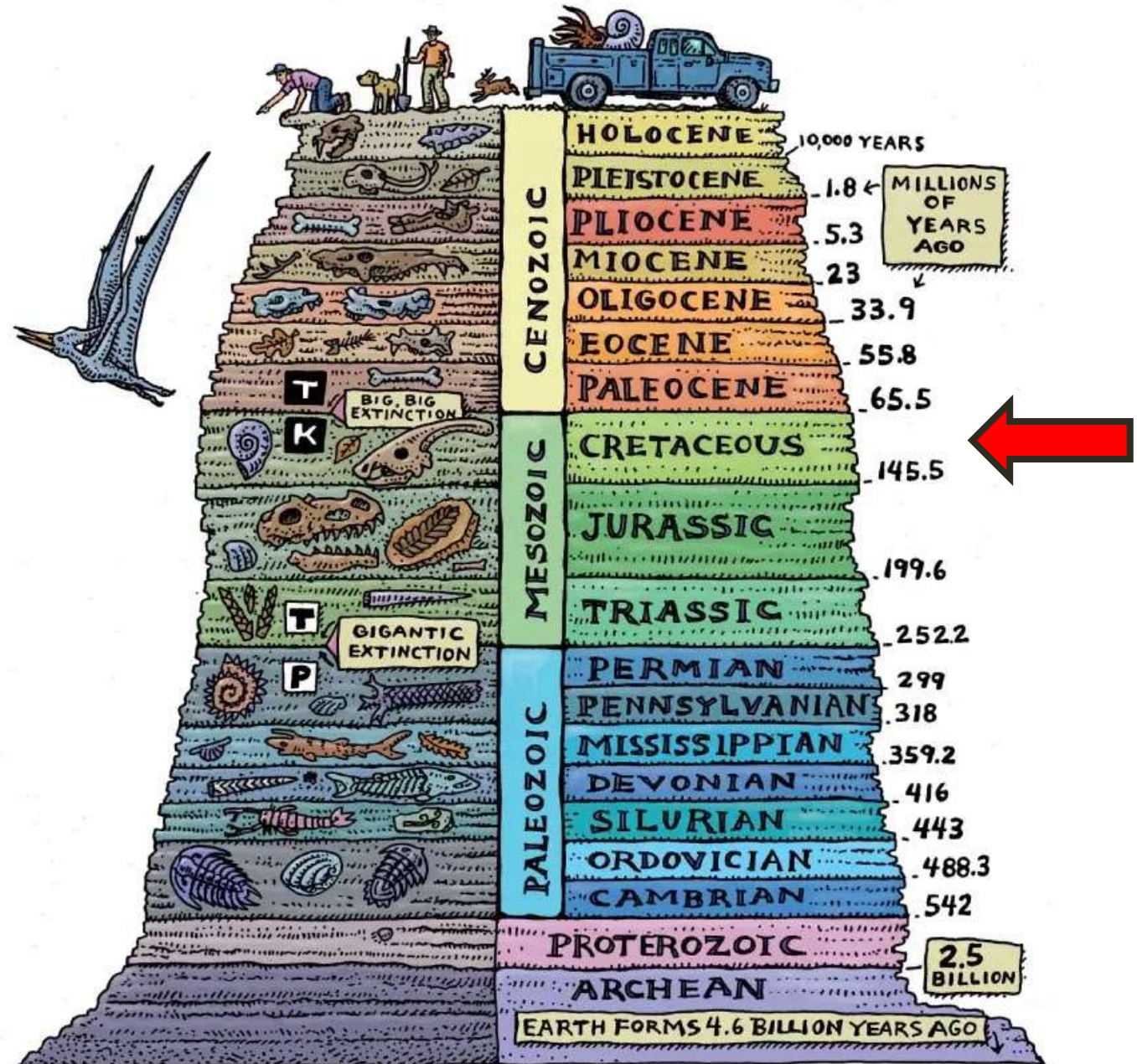
Genera and families are a different story...

METASEQUOIA

Fossil genus *Metasequoia* reported in 1941. Living trees were documented a few years later. Here are some fossilized leaves from 100 million years ago.



TIMELINE



METASEQUOIA

Metasequoia was known from a large fossil record prior to the discovery of the living species *Metasequoia glyptostroboides* in China. The fossils are tagged as belonging to extinct species of *Metasequoia* (*M. foxii*, *M. milleri*, and *M. occidentalis*).



Before the discovery of the living dawn redwood, many of these fossils were thought to be extinct species of *Sequoia* (e.g. *S. occidentalis*).

THE PROBLEM WITH FOSSILS

To identify plants you need to see multiple organs such as leaves, seeds, flowers, pollen, bark, and roots. You almost never get these all together in the same fossil, as plants tend to break apart in death. With ancient plants, we are using distorted fragments to build a picture of what the actual organism looked like, with no close living relatives to reference.

Plant fossils form through permineralization, compression, carbonization, impressions and casts.

FERNS

One of the oldest groups of plants, fern fossils date back to the Devonian (383-393 million years ago). Tree ferns have fossil record dating back to the Triassic (251 to 199.6 million years ago).

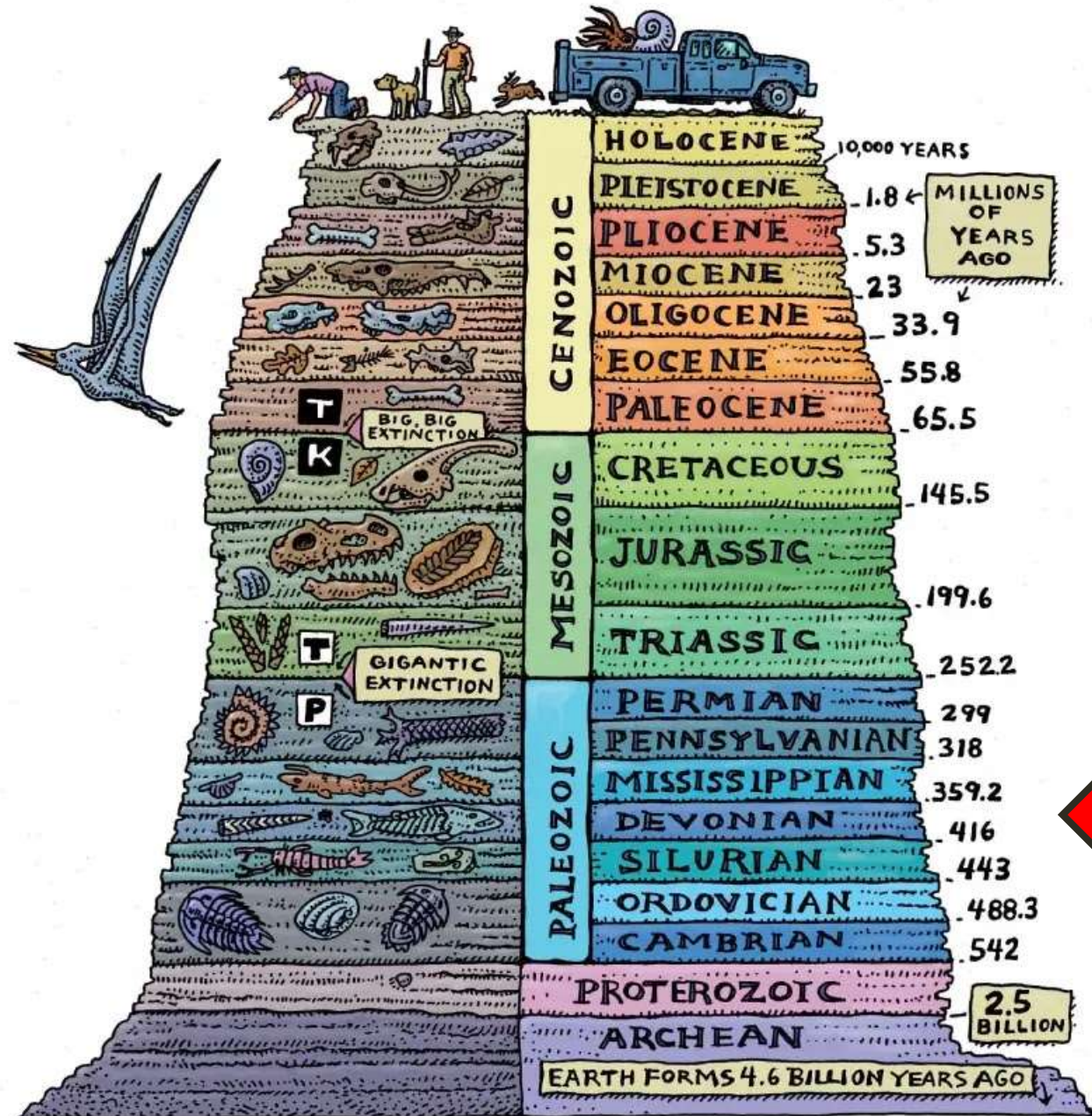


EQUISETUM

Equisetum is the only living genus of an entire subclass of ferns, Equisetidae, which dominated the understory of late Paleozoic forests.



TIMELINE



EQUISETUM

Modern horsetails (genus *Equisetum*) first appeared in the Early-Middle Jurassic Period. More ancient relatives are known from fossils dating back to the Devonian period, over 350 MYA.

Fossils of different parts of the plants were given their own botanical names. *Annularia* is a name applied to fossil foliage, while stem fossils are called *Calamites*.



FOSSIL TAXA

A form or organ taxon is a botanical name assigned to a fossil of a plant part. Since plants disintegrate when fossilized, paleobotanists are usually working with fragments. It is difficult to tell which leaf, stem, fruit and flower parts belong together. Each part is given its own taxon name to reflect this uncertainty.



Based on fossils, *Calamites* could be 30 m tall.

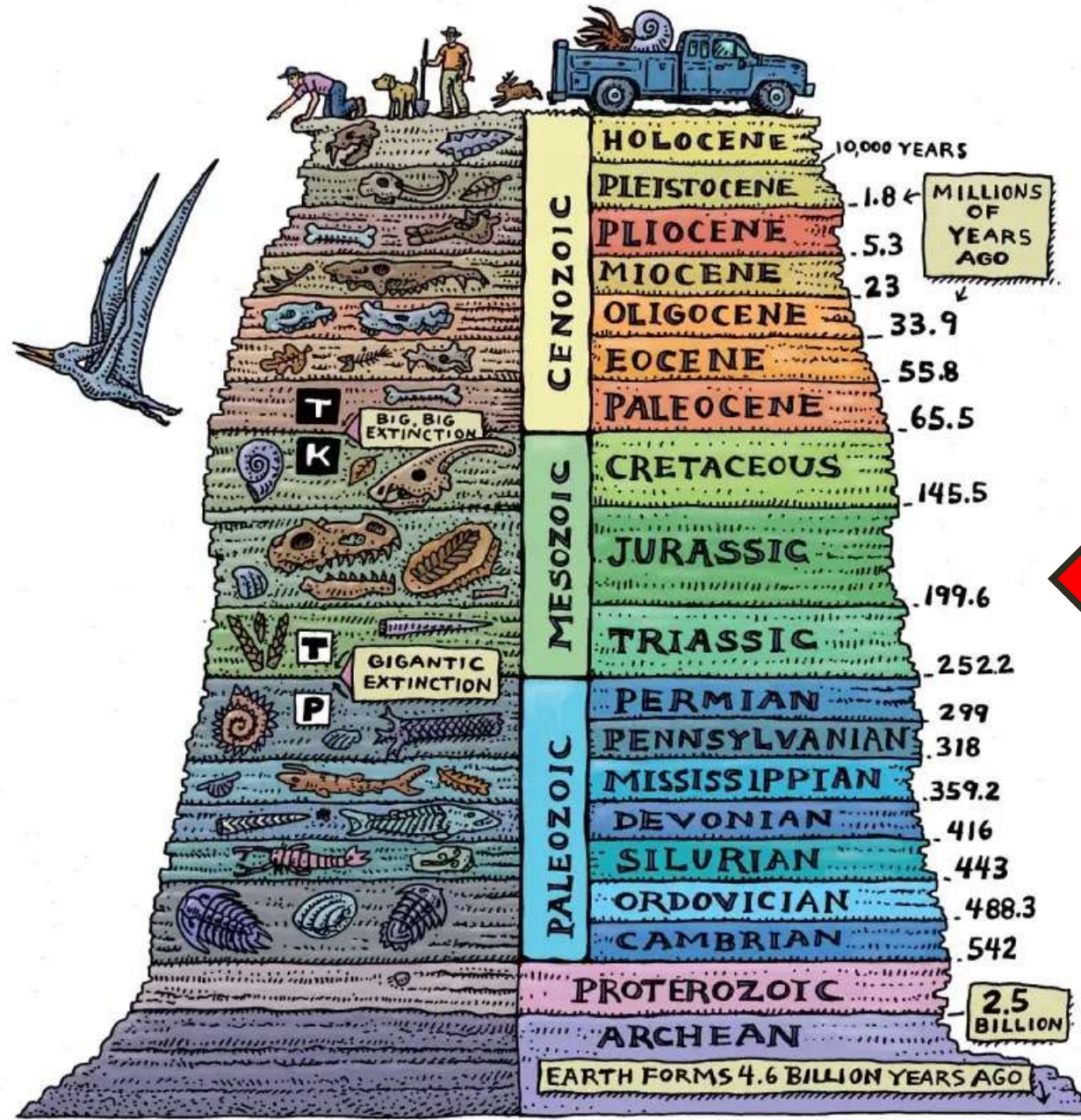


GINKGO

A plant lineage that diverged in the late Paleozoic. *Ginkgo* fossils date back to the early Jurassic, about 190 million years ago.



TIMELINE



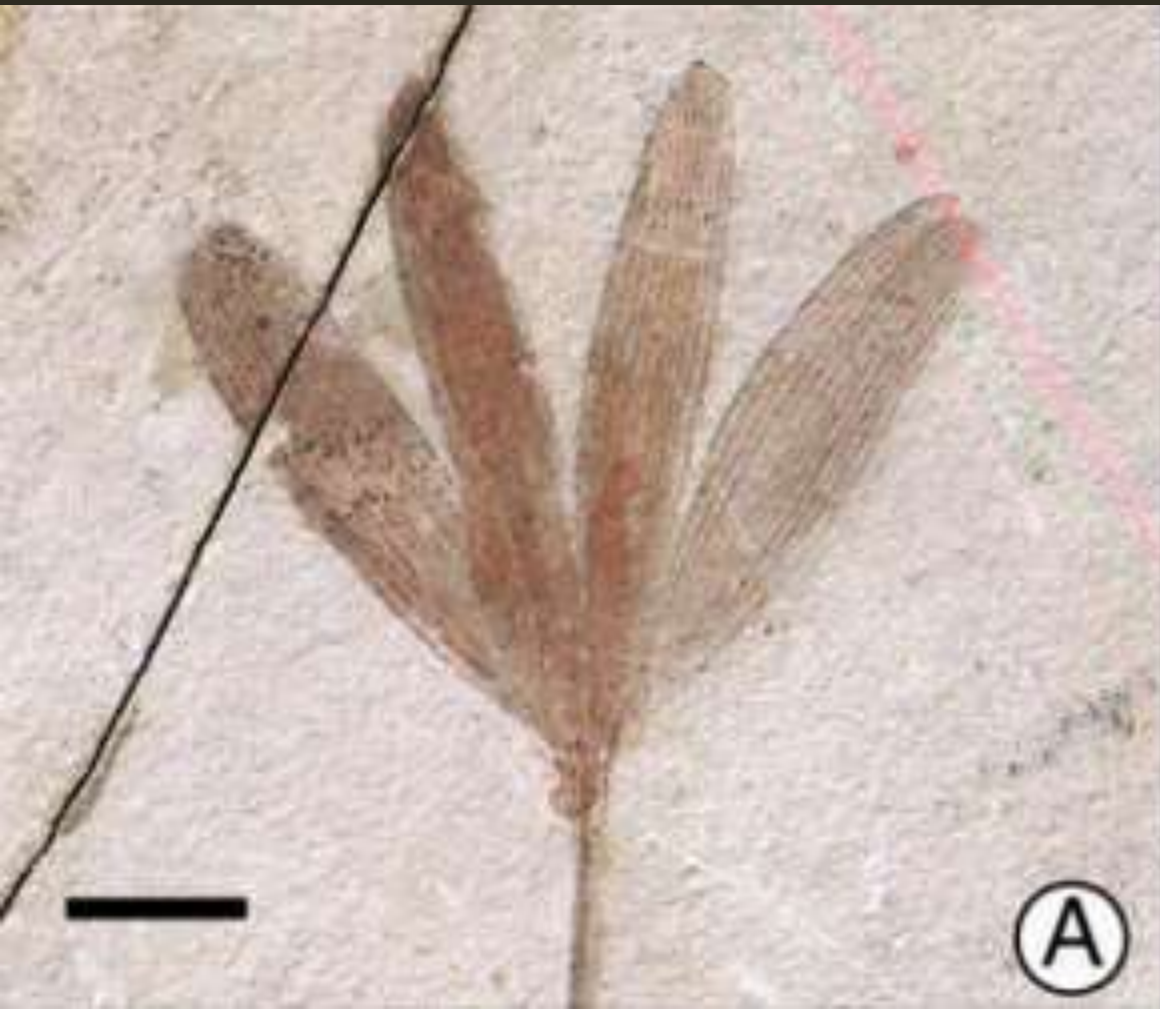
GINKGO

Here is a carbonaceous film of ginkgo leaves, possibly *Ginkgo* (or *Ginkgoites*) *huttonii*, from the Middle Jurassic. *Ginkgoites* is a name created for fossil leaves that are identical or very similar to *Ginkgo* leaves.



GINKGO

Fossil found of hanging fly *Juracimbrophlebia ginkgofolia* that appears to mimic extinct ginkgo relative *Yimaia capituliformis*. *Yimaia* is from an extinct family called Yimaiaceae, also in order Ginkgoales.

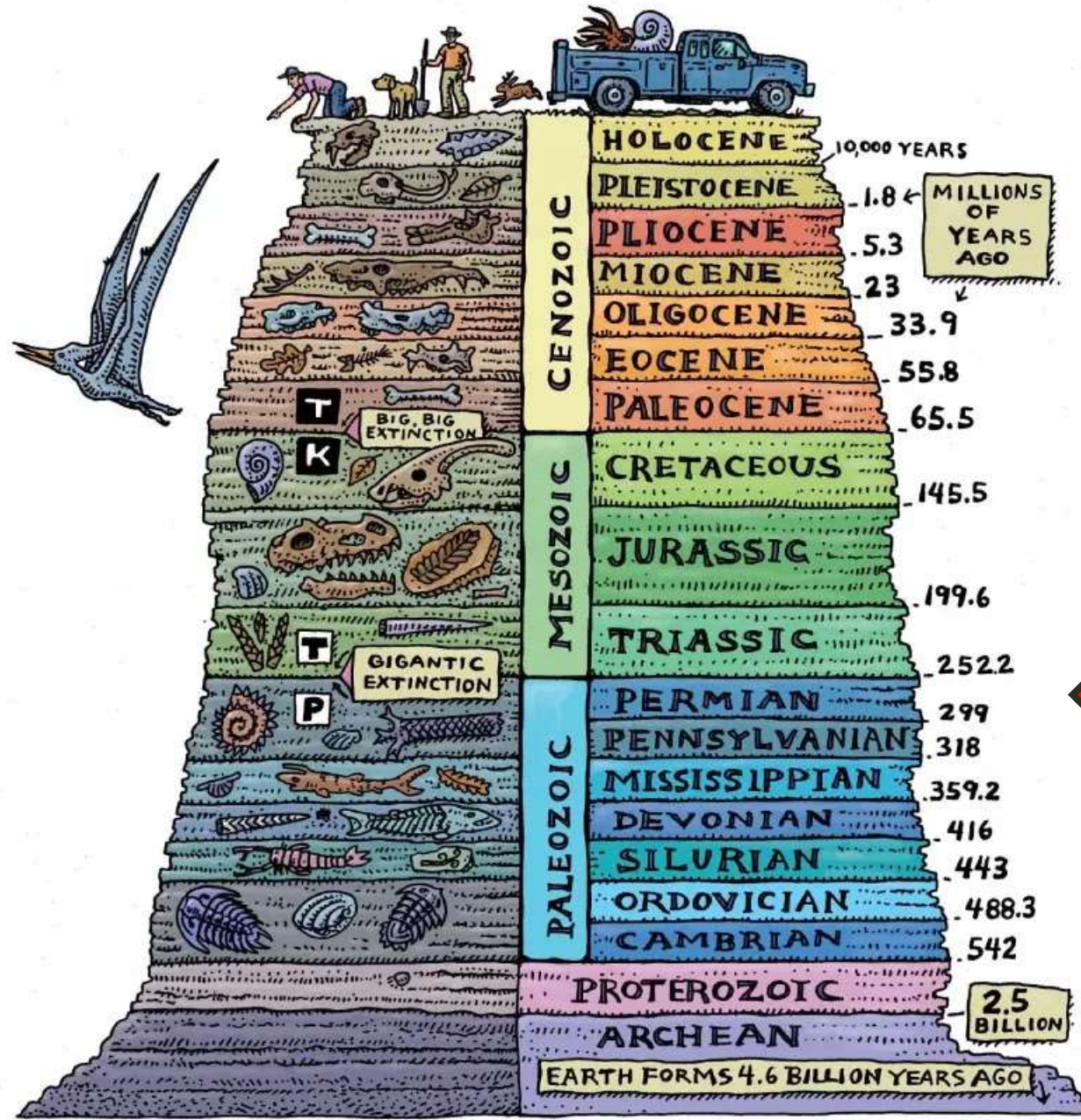


CYCADS

Cycads diverged in the Permian and dominated terrestrial ecosystems during the Mesozoic. Our understanding of their evolutionary history has changed a lot in the last few decades.



TIMELINE

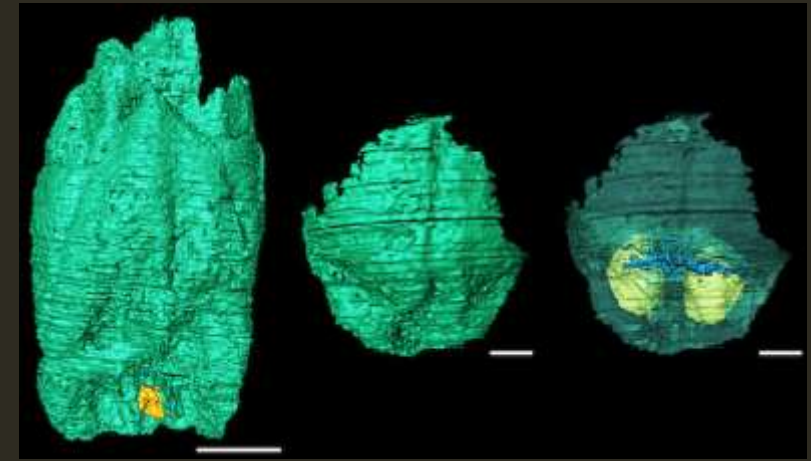


CYCADS

25% of all gymnosperms are cycads. Over 300 species today, many endangered. They resemble palm trees but are from a different order of plants and not closely related at all. Dioecious, separate male and female plants.



CYCAD DISCOVERIES



Recent Synchronous Radiation of a Living Fossil:

In 2011 a study at UC Berkeley used “fossil-calibrated molecular phylogenies”, found that cycads underwent a global rediversification event (diversified in Cretaceous, dominant and numerous, dwindled and then radiated again in Miocene and Pliocene) about 12 million years ago (Miocene climate cooling).

A recent find of a great permineralized cycad pollen cone fossil (80 MYA) in California suggests that modern cycads are quite different from ancient cycads. Internal anatomy and pollen preserved. Scanned and studied by University of Kansas in 2023, assigned to genus *Skyttegaardia*, previously known from fossil cone scales found in Denmark in 2021.

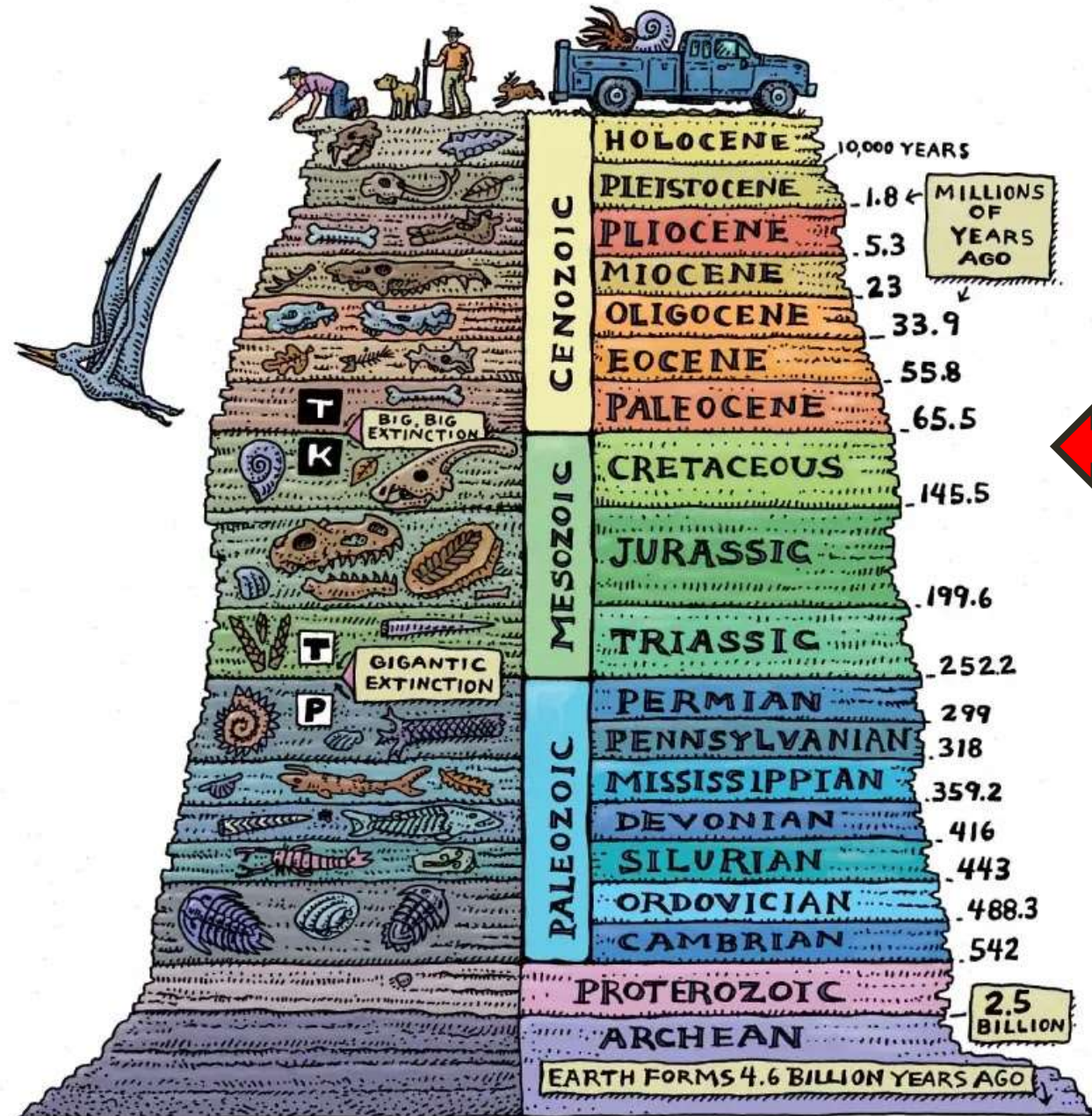
Molecular clock hypothesis – “DNA and protein sequences evolve at a rate that is relatively constant over time ... Genetic distances between any two species is proportional to the time since these species last shared a common ancestor.” – Nature.com

GUNNERA

Fossil history mostly from fossilized pollen spores, known by the palynotaxon *Tricolpites reticulatus*. Gondwanan lineage, originated in South America during the Cretaceous. Earliest known fossil pollen dates to Late Cretaceous, about 90 million years ago.

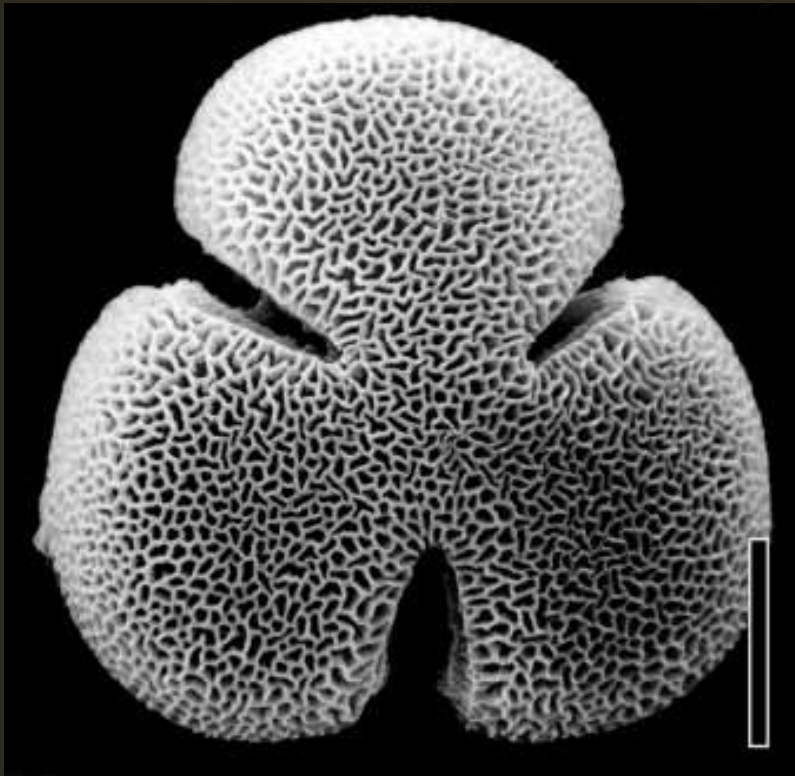


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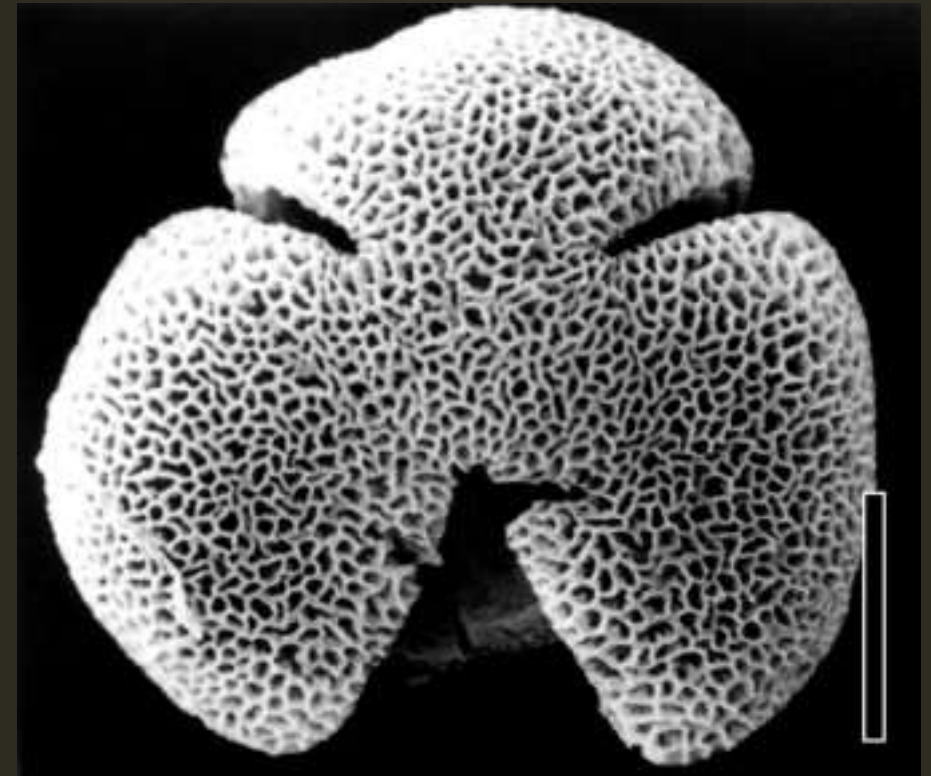


GUNNERA POLLEN

Palynology, from the Greek palyno (to sprinkle or strew), means “the study of little sprinkled bits”. Pollen is tough, tiny and tends to fossilize intact, great for identification.



Gunnera macrophylla



Tricolpites reticulatus

WOLLEMI PINE

Despite being a living fossil, no unambiguous fossils of *Wollemia* have been found. The leaves resemble fossils of its ancient ancestors in the Araucareaceae (Monkey Puzzle Family).

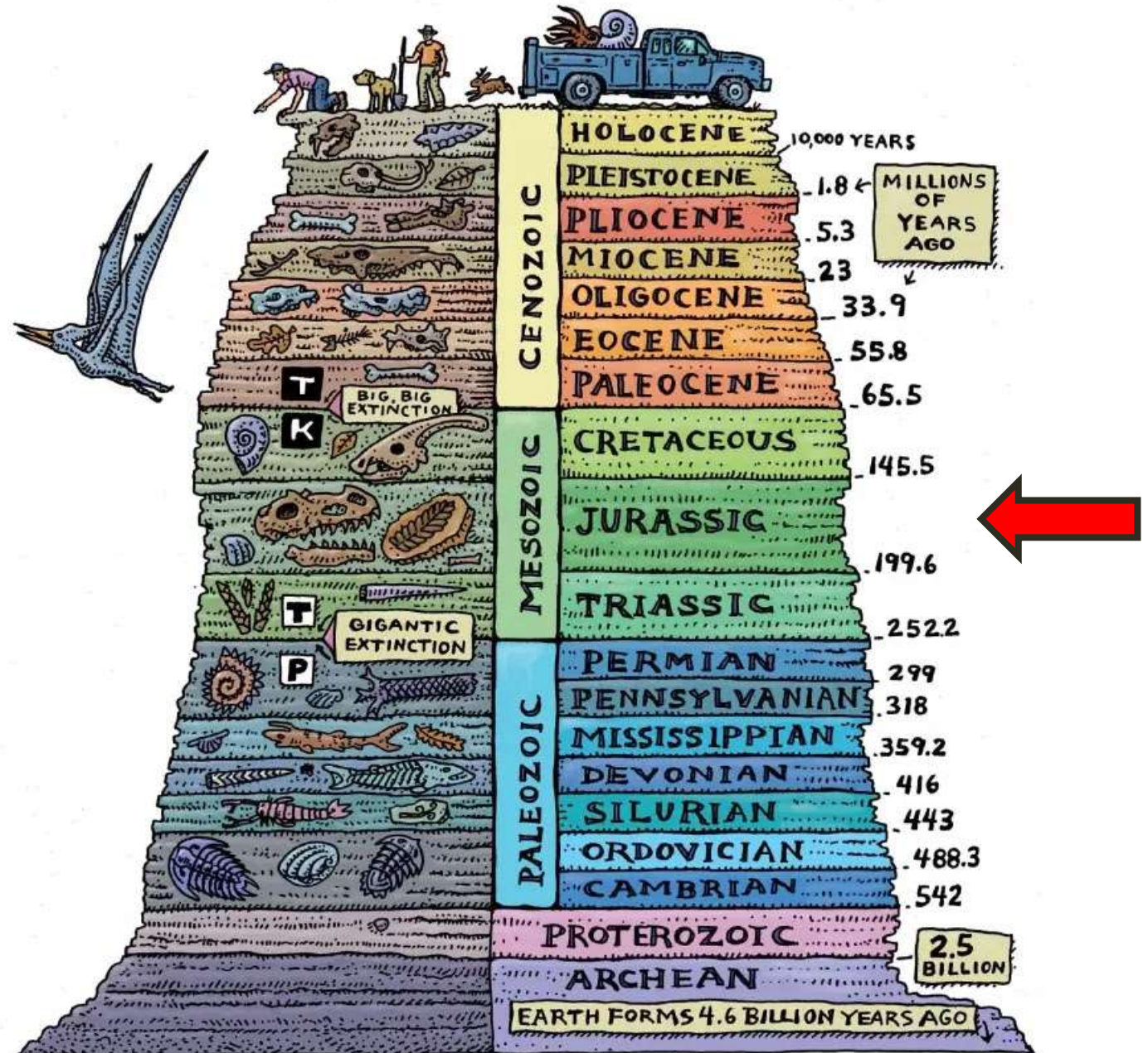


MONKEY PUZZLE

Fossils show the genus *Araucaria* was present in the Northern Hemisphere until the end of the Cretaceous. For example, fossil cones of *A. sphaerocarpa* dating to Middle Jurassic were found in Somerset, England in the 1860's.



TIMELINE



MONKEY PUZZLE



Extinct species
Araucaria mirabilis is known from well-preserved wood and cone fossils found in Patagonia at a site buried by volcanic ash 160 MYA.

CUNNINGHAMIA

Cunninghamia is the most basal extant genus of Cupressaceae – its lineage diverged during the early Jurassic. Oldest fossil species of the genus is from late Cretaceous (*C. hornbyensis* & *C. taylorii* from BC and Alberta).



FLOWERING PLANTS

Flowering plant fossils date back to Early Cretaceous. Based on genetic analysis, Amborellales, Nymphaeales and Austrobaileyales (ANA-grade angiosperms) are the living representatives of lineages that diverged the earliest in flowering plants.

Flowering plants (Angiosperms) may have appeared earlier than the Cretaceous, but we haven't found any fossils to confirm that (yet).

Despite diverging early in the angiosperm phylogenetic tree, their features are not necessarily representative of ancient flowering plants. For example, *Amborella* and some magnoliids lack vascular features seen in most eudicots and monocots. They may have lost those features over the course of adaptation and evolution, rather than inheriting it from their ancestors.

Plants like these are often referred to as “primitive”, which is inaccurate. Some botanists get mad about it – I keep seeing papers with defensive titles like “Hardly a relict: freezing and the evolution of vesselless wood in Winteraceae.”

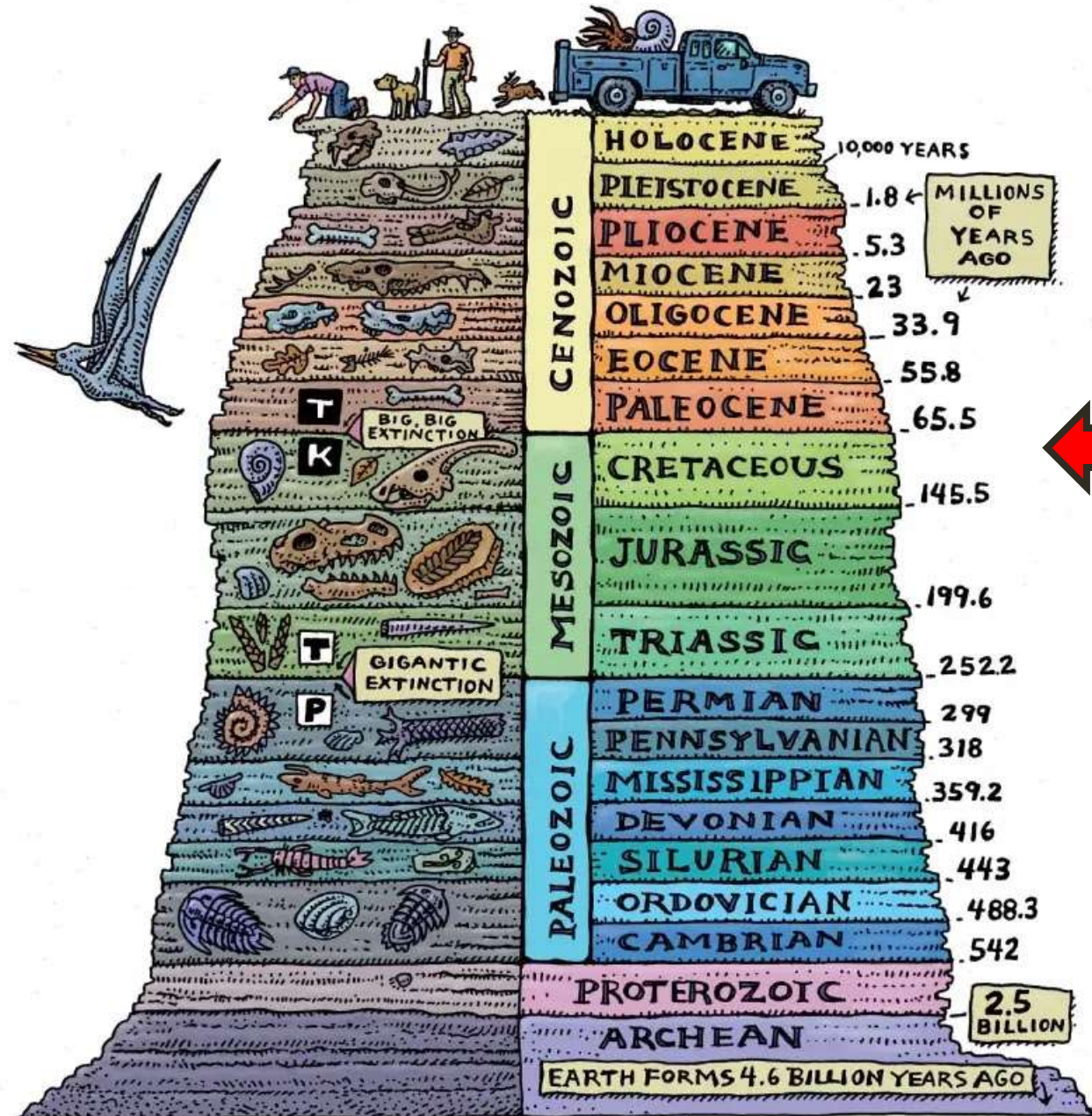


MAGNOLIACEAE

Magnoliaceae fossils date back 95 million years, diverged from other flowering plants (monocots and eudicots), but not the most basal lineage. Living members include *Magnolia* and *Liriodendron*.



TIMELINE



MAGNOLIA

A leaf fossil very similar to *Magnolia acuminata* was found at the Clarkia fossil beds in Idaho dating 20 MYA.



*Fossil leaf impression (specimen RBF-20)
of Miocene Clarkia Magnolia sp.
(resembling extant M. acuminata).*



Extant M. acuminata leaf.



CONCLUSION

A living fossil is an organism that physically resembles its ancient ancestors that are known from the fossil record.

Living fossils are not primitive - they are separated from their ancestors by tens to hundreds of millions of years of evolution, even if they look similar.

