

**March 28, 2022**

## **News and notes**

I've updated the [Home Page](#) to this weblog with a list of interesting/useful podcasts and YouTube channels. So, before going on with a look at terrestrial life during the Permian Period, let's take a look at some news items that I think are interesting.

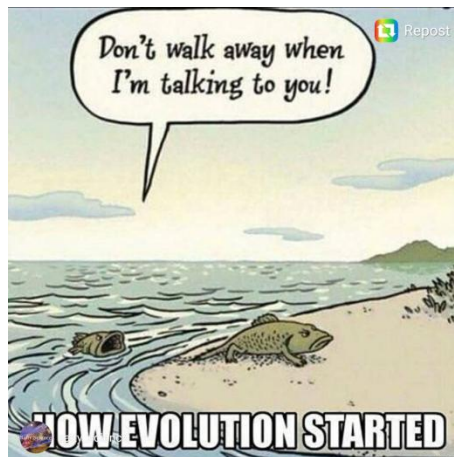
## **Geopolitics**

The war in Ukraine continues. Here are some news items on the war.

- Surprise, surprise: [Defense Giants Quietly Making Billions on Ukraine War](#).
- Russian commanders lead from the front, it costs them: [Russia suffers worst loss of military leaders since World War Two](#).
- Whoops: [Ukraine Says Russia Accidentally Bombed Its Own Rosneft Refinery](#).
- [Ukraine invasion's impacts on the world of science: Live updates](#).
- [Daily updates here](#) and [here \(en Française\)](#).

## **Paleontology Research**

- Evolution of terrestrial animals: [Modern animal life could have origins in delta](#), or maybe it was this:



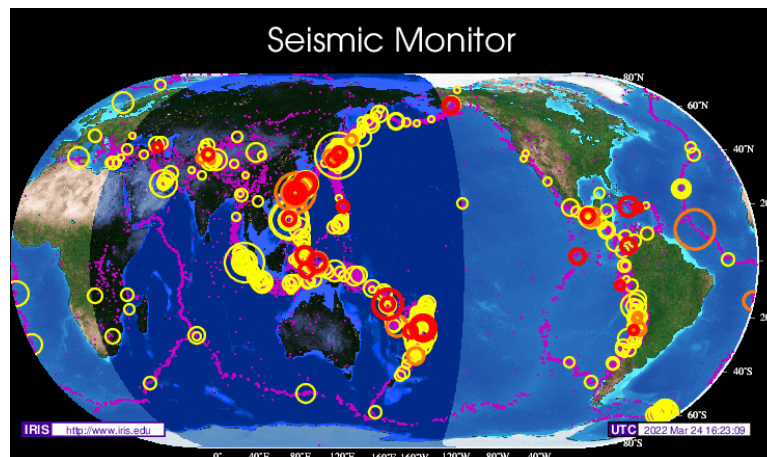
Credit: <https://www.pinterest.com.au/pin/264938390565199892/>

- [Fossil Bug Discovered in Baltic Amber Looks Remarkably Like a Mantis](#), research paper [here](#).
- [Scientists Described a Dinosaur's Butthole in Exquisite Detail](#); research paper [here](#).
- [Sulfur from dino-killing asteroid caused way more global cooling than thought](#).
- More dinosaurs: [Recently Unearthed Skull With Knife-Like Teeth Could Be New Species of Basilosaurus](#).

## Other Research

- From New York University: [The Earth Has a Pulse—A 27.5-Million-Year Cycle of Geological Activity](#).
- Proterozoic oxygen concentrations higher than previously thought: [Triple oxygen isotope constraints on atmospheric O<sub>2</sub> and biological productivity during the mid-Proterozoic](#).
- Sedimentology: [Tracking head-to-head encounters of mobile dune fields on seafloor](#), research paper [here](#).
- [New study of Yellowstone National Park shines new light on once hidden details of the famous American landmark](#).
- Quaternary research: [The age of the opening of the Ice-Free Corridor and implications for the peopling of the Americas](#).
- Geophysics and the Earth's core: [Satellite magnetic data reveal interannual waves in Earth's core](#).
- End Triassic extinction: [How a major volcanic eruption paved the way for the rise of the dinosaurs](#).
- [Greenland tidewater glacier advanced rapidly during era of Norse settlement](#); related [Why Did Vikings Mysteriously Leave Greenland? We May Finally Know The Reason](#).
- Origins of diamonds: [Composition of Diamond from the 95-2 Pipe, Lake Timiskaming Kimberlite Cluster, Superior Craton, Canada](#).

## Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)

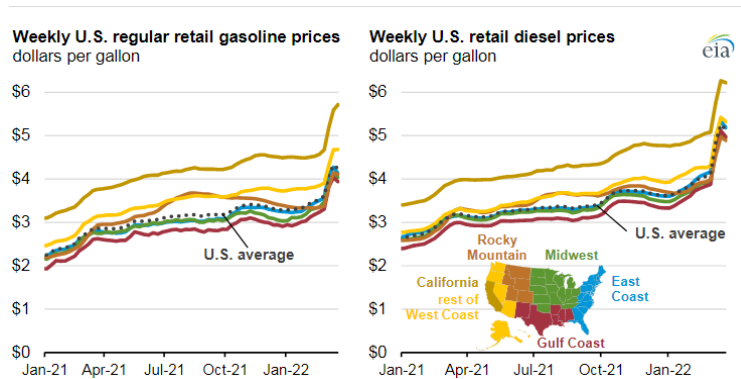
- [M 5.8 - 9 km SE of Esmeraldas, Ecuador](#).
- [Earthquake Swarm São Jorge Island in the Azores](#); March 28 [update](#).
- Volcanoes and climate: [The Surprising Greenhouse Gas That Caused Volcanic Summer](#).
- Predicting earthquakes: [Undersea sediment reveals clues about seismic activity](#).
- Submarine landslides: [Widespread Fluid Seepage Related to Buried Submarine Landslide](#)

[Deposits in the Northwestern South China Sea](#), includes plain language summary.

- [Worldwide Volcano News and Updates](#).

## Energy and Mining

- [Mining firm backed by Bezos and Gates to begin Greenland drilling](#); "The objective is to target massive nickel, copper, cobalt and platinum group metals".
- Energy storage research: [Pivotal battery discovery could impact transportation and the grid](#).
- Energy politics and regulation: [With The Ukraine War, The Green Chickens Have Come Home To Roost](#).
- From the United States Energy Information Administration (USEIA): [U.S. gasoline and diesel prices declined slightly the week after their March 14 peak](#).



**Credit: USEIA, Gasoline and Diesel Fuel Update**

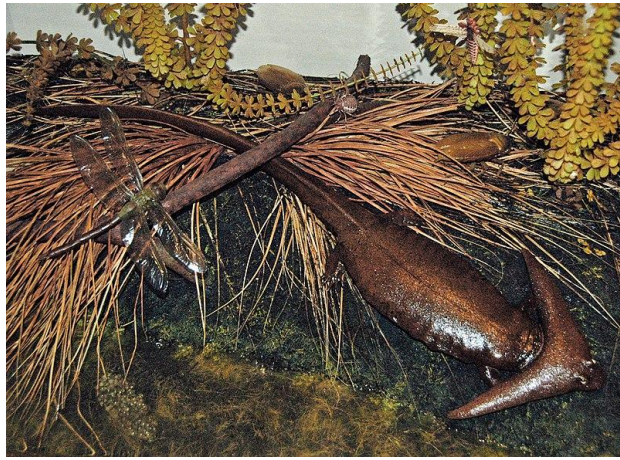
- Also from the USEIA: [U.S. exported record amounts of liquefied natural gas in 2021](#).
- [Nickel price turmoil is back as prices spike 15% again to hit limit](#).
- [Gold mining firms should cooperate more with artisanal miners, WGC says](#); artisanal miners are sometimes referred to as "illegal" miners in the news.
- [Saudi Aramco petroleum storage site hit by Houthi attack, fire erupts](#).
- [Fire at ExxonMobil refinery in Montana under investigation](#).
- Cut down old growth forest to put up wind turbines, going to cause problems: [Leading Environmental Group NABU Now Vigorously Opposes Wind Parks In German Forests](#).

## Field Work Can Be Dangerous

- [Body of missing geology professor found in TN lake, cops say. 'Lost a bright light'](#).
- [Uganda attack kills geologists, army head threatens "hell"](#).

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## Terrestrial Life during the Permian



**Figure 1 - Diorama of a Permian forest floor - *Diplocoeraspis***  
**Credit: [James St. John, Creative Commons Attribution 2.0 Generic](#) license**

The story of terrestrial life during the [Permian Period](#) is one of diversification and adaptation. Underlying the changes was increasingly drier conditions, ultimately caused by the accretion of [Euramerica](#) and [Gondwana](#) into [Pangaea](#). The great coal swamps of the [Carboniferous Period](#) ([Mississippian and Pennsylvanian](#)) in what is now Europe and North America were gone, although coal swamps persisted in [Australia during the Permian](#). A wide variety of terrestrial habitats evolved during the Permian and that led to a great diversity of plants and animals. Let's look at some examples of Permian terrestrial life as shown in the fossils from that period.

### Terrestrial Plants

#### *Pteridospermophyta* (seed ferns)



**Figure 2 - *Glossopteris* Fossil Seed Fern Leaves in Claystone**  
**Credit: [James St. John, Creative Commons Attribution 2.0 Generic](#) license**

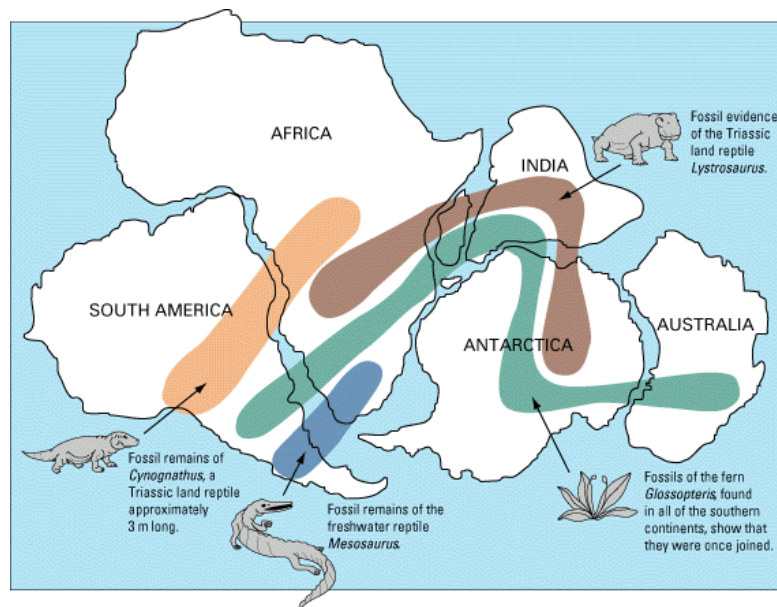


*Glossopteris* was a seed a genera of seed ferns (*Pteridospermophyta*) that are first found during the [Early Permian](#) in the southern hemisphere and persisted until the [End Permian Mass Extinction](#). *Glossopteris* grew as a woody, seed-bearing shrub or tree in wet, swampy conditions, such as those that led to the deposition of [Permian age coal deposits in Australia](#). The [evidence](#) suggests that *Glossopteris* was deciduous, although some research suggest that that the genera included [both deciduous and evergreen species](#).

**Figure 3 - Reconstruction of *Glossopteris***

**Credit:** [Cool Dino Facts](#), [Creative Commons Attribution-Share Alike 3.0 Unported license](#)

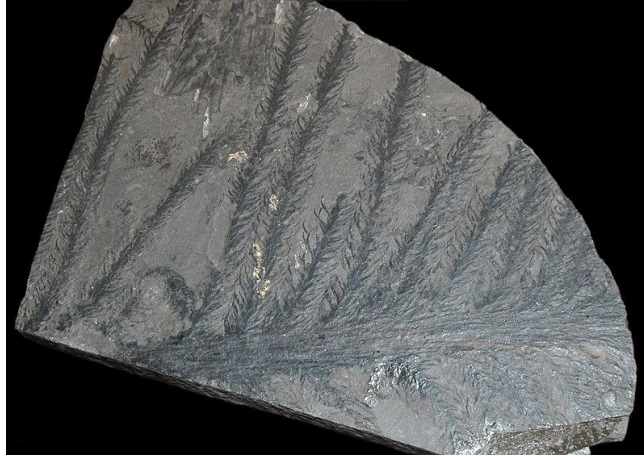
Species of the genus *Glossopteris* are found throughout the lands that made up ancient Gondwana: India, South America, Australia, Africa, Madagascar and Antarctica. In fact, the distribution of *Glossopteris* was one of the pieces of evidence that led to the idea that Gondwana and Pangaea existed in the Permian Period originally proposed by [Antonio Snider-Pellegrini](#) and Alfred [Wegener](#).



**Figure 4 - Snider-Pellegrini Wegener Fossil Map**

**Credit:** [United States Geological Survey \(USGS\)](#), [public domain](#)

## Conifers - *Walchia*



**Figure 5 - *Walchia* Fossil, Naturhistorisches Museum Vienna**  
**Credit: [Gyik Toma](#), [Creative Commons Attribution 2.0 Generic](#) license**

[Walchia](#) was an early conifer that lived from the Late Carboniferous to the Early Permian. Among the locations where this fossil is found, there is a whole forest of in-situ *Walchia* tree-stumps near [Brule, Nova Scotia](#).

[Fossils of Walchia](#) are also found across the Northumberland Strait from Brule in Prince Edward Island. The study in the link indicates that between the Early Carboniferous and Early Permian, the region migrated from the southern subtropics to the northern subtropics.

[The Sam Noble Museum, Oklahoma's Museum of Natural History](#), in Norman, Oklahoma has an entire [gallery of Walchia fossils](#), check out the link.

Also interesting, fossils of *Walchia piniformis* are associated with [Dimetrodon teutonis](#) in the Permian [Tambach Formation](#) of Central Germany.



**Figure 6 - *Dimetrodon teutonis* and the conifer *Walchia***  
**Credit: [PaleoEquii](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license**

## Terrestrial Animals

### *Dimetrodon*

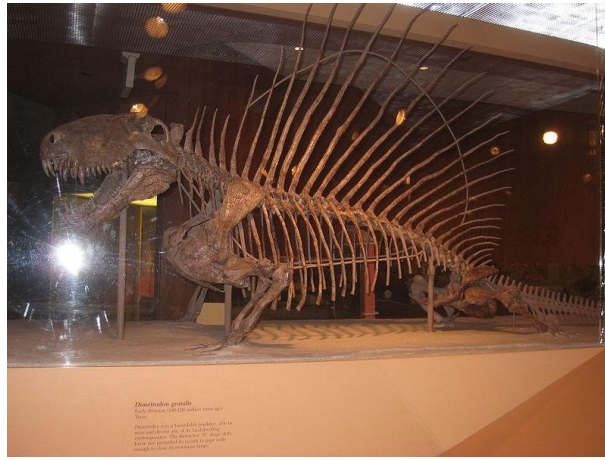


Figure 7 - *Dimetrodon grandis*, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA  
Credit: [Daderot](#), public domain

If you ever had a collection of toy dinosaurs when you were a child, chances are one of the models was of a [Dimetrodon](#). Funny thing is, *Dimetrodon* wasn't a [dinosaur](#) at all but rather it was a [synapsid](#) reptile that went extinct some 40 million years before the first true dinosaurs appeared. In fact, *Dimetrodon* was more closely related to the earliest ancestors of mammals than dinosaurs.



Figure 8 - Toy Model of a *Dimetrodon*  
Credit: [petelovespurple](#), [Creative Commons Attribution 2.0 Generic](#) license

The some [20 species of Dimetrodon](#) lived during the Early Permian. Most fossils of the genera have been found in the Southwestern United States, particularly in the [Red Beds of Texas and Oklahoma](#). Fossils of *Dimetrodon* have also been [found in Germany](#). *Dimetrodon* was a

predator, a large one like *Dimetrodon grandis* was probably an [apex predator](#).

### ***Captorhinus***



**Figure 9 - *Captorhinus aguti***

**Credit: [Didier Descouens, Creative Commons Attribution-Share Alike 4.0 International license](#)**

Another reptile from the Early Permian Period is [Captorhinus](#). First discovered in 1882 by [Edward Cope](#), fossils of the genus have been found in Texas, Oklahoma, and New Mexico. Outside the United States, *Captorhinus* fossils occur in Europe, India, Brazil and Zambia.

### ***Amphibians - Diploceraspis***



[Diploceraspis](#), together with its closely related [Diplocaulus](#), was an ancient [lepospondyl](#) amphibian that lived in North America during the Permian. Both *Diploceraspis* and *Diplocaulus* had, in what appears our eyes, a weird shaped skull similar to the modern [hammerhead shark](#). That [odd shaped skull](#) was a form of protection against predators or might have acted as a ballast to keep it on the bottom of the water. *Diploceraspis* was about 46 cm long and its fossils have been found in pond or lake deposits.

**Figure 10 - *Diploceraspis***

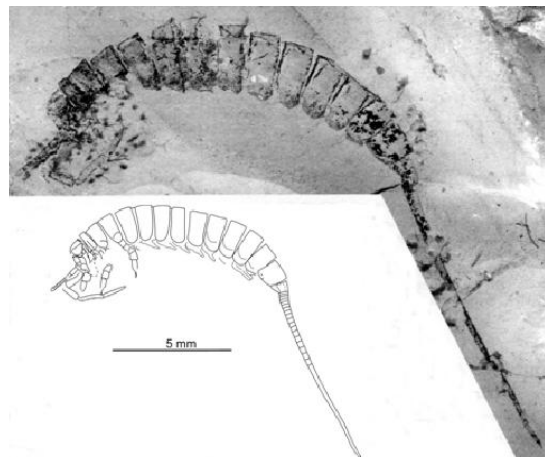
**Credit: [Dmitry Bogdanov, Creative Commons Attribution-Share Alike 3.0 Unported license](#)**

## ***Insects - Monura***



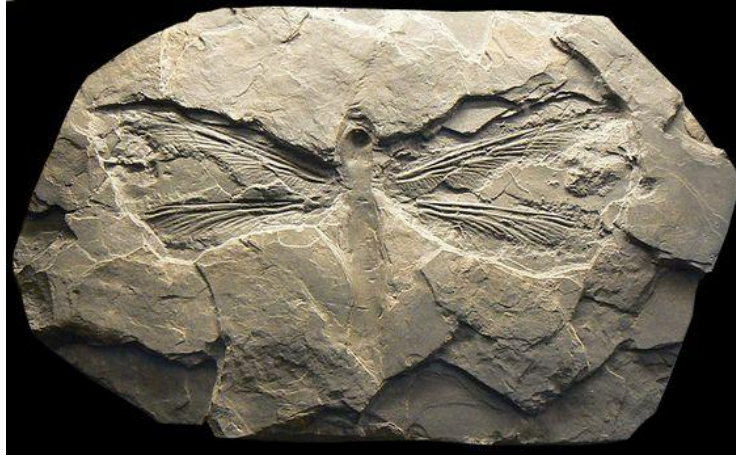
**Figure 11 - Fossil Trackways, Alabama**  
**Credit: [Alabama Paleontological Society](#)**

[Monura](#) were an suborder of insects in the order [Archaeognatha](#) of which the best known modern insect is the [silverfish](#). They are mostly known from trace fossils called trackways and many fossil trackways associated with the conifer *Walchia* are thought to be Monura. Good fossils of Monura insects are rare, [Dasyleptus brongniarti](#) is a Monura from the Middle Permian.



**Figure 12 - *Dasyleptus brongniarti***  
**Credit: [Rinehart, L. F., Rasnitsyn A. P., Lucas, S. G., and Heckert, A. B., 2006](#)**

## ***Meganeuropsis***



**Figure 13 - Fossil of *Meganeuropsis permiana***  
**Credit: [4.bp.blogspot.com](http://4.bp.blogspot.com)**

No discussion of fossil animals from the Permian would be complete without the giant dragonfly, actually a [griffinfly](#), *Meganeuropsis*. There are two known species of *Meganeuropsis*: *Meganeuropsis permiana* and *Meganeuropsis americana*. *M. permiana* was first found in 1939 in the Early Permian [Wellington Formation](#) of near [Elmo, Kansas](#); it had a wingspread of 710 mm and a body length of 430 mm. *M. americana* was first found in 1940 near [Noble, Oklahoma](#) and had an estimated wingspan of 690 mm. An amusing website by an extermination company, Terminix, describes "[5 Giant Bugs We're Glad Are Extinct](#)" and includes *Meganeuropsis permiana* as No. 1.

Studying these things can be quite fun, Figure 14 shows a reconstruction of *Meganeuropsis*.



**Figure 14 - Reconstruction of *Meganeuropsis***  
**Credit: Werner Kraus, [Creative Commons Attribution-Share Alike 4.0 International](#) license**

## ***Palaeodictyoptera***

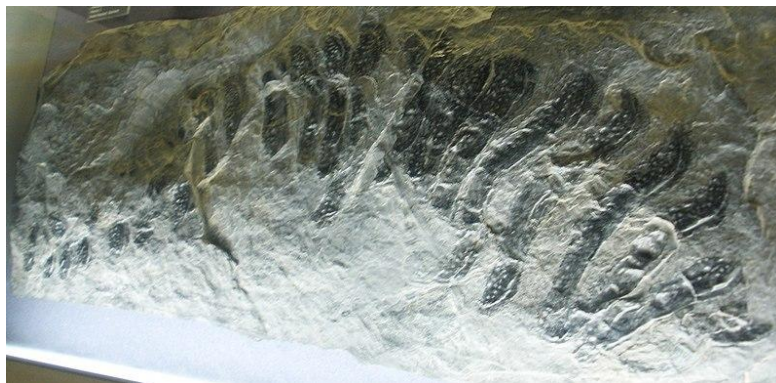


**Figure 15 - Reconstruction of *Dunbaria fasciipennis*, a species of Palaeodictyoptera**  
**Credit: [Zoological excursions on Lake Baikal](#), [Creative Commons Attribution](#)**

The most primitive of all flying insects, [Palaeodictyoptera](#), (sometimes called six winged insects) were among the first herbivorous insects. Evolving in the Early Permian, they had a major impact on terrestrial ecosystems by directly eating living plants compared to earlier herbivores that ate only rotting vegetation ([detritivores](#)). Palaeodictyoptera flourished and were probably the major prey animals for creatures such as *Meganeuropsis*. One overall effect of the evolution of Palaeodictyoptera on the terrestrial ecosystems was to transform them into recognizably modern systems with detritivores, herbivores and carnivores all of which were ultimately dependent on the growth of herbaceous plants.

The reconstruction of [Dunbaria fasciipennis](#) shown in Figure 14 is based upon [fossils](#) discovered in the [Wellington Formation](#) of Kansas. The fossils preserved the original colour patterns of bright and dark patches but not the actual colour. The Palaeodictyoptera went extinct during the End Permian Mass Extinction, the only major clade of insects to become extinct.

## ***Arthropleura***



**Figure 16 - Fossil of *Arthropleura armata***  
**Credit: [Ghedoghedo](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license**

A giant [millipede](#) (an [arthropod](#), but not an insect), *Arthropleura* lived from the lower Carboniferous Period to the Early Permian Period. *Arthropleura* ranged in length from about 0.3 metres long to *Arthropleura armata* which was 2.5 metres long and is listed by Guinness Book of Records as the [Largest terrestrial invertebrate ever](#). Trackways of *Arthropleura* are found at [Joggins](#), Nova Scotia measuring 55 cm wide for an and an estimated length of 1.9 metres.



**Figure 17 - Reconstruction of *Arthropleura***  
**Credit: [James St. John](#), [Creative Commons Attribution 2.0 Generic license](#)**

Although they probably lived in the coal swamps during the Carboniferous, after the [Carboniferous rainforest collapse](#), *Arthropleura* survived outside the forests, as witnessed by trackways of the millipede from more [open environments](#).

### **Why Did They Get So Big?**

The giant insects of the Permian are a bit of a riddle since no contemporary insects grow to the size of those in the later [Paleozoic](#). There seems to be two explanations:

First is that oxygen concentrations in the atmosphere were higher. [Edouard Harlé](#), first suggested this in 1911. However, this has since been re-examined. [Recent research](#) suggests a link between oxygen supply and gigantism but there is reason to believe that [oxygen levels in the Upper Permian](#), when *Meganeuropsis* was around, were much lower than earlier times. Another factor is air pressure, a higher partial pressure of oxygen would allow for proper respiration in giant insects. See also: [Atmospheric oxygen, giant Paleozoic insects and the evolution of aerial locomotor performance](#).

[Another suggested explanation](#) is simply that they could. A lack of predators allowed the insects to evolve to giant sizes. As well, there may have been an "[evolutionary arms race](#)" between plant eating Palaeodictyoptera and their most likely predators [meganeurids](#) including *Meganeuropsis* leading to bigger prey being chased by bigger predators.

### **Standard Caveat**

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.