

**December 20, 2021**

First, since my next posting will be after Christmas on December 27, I would like to wish you all a **Merry Christmas**. Here is link to my favourite Christmas song, the [Fairytale of New York](#) by the Pogues.

### **News and notes**

Before going on with a further discussion on the Cambrian Period, here are some news items that I thought were interesting.

### **Paleontology**

- New species of *Quetzalcoatlus* named: [Journal of Vertebrate Paleontology, Volume 41, Issue sup1 \(2021\)](#), see also [The Quetz Monograph Lives and Other News on Azhdarchid Pterosaurs](#) and the [7 Days of Science](#) YouTube site for December 15th.
- Also via 7 Days of Science, [Ichthyosaurs from the Upper Triassic \(Carnian–Norian\) of the New Siberian Islands, Russian Arctic, and their implications for the evolution of the ichthyosaurian basicranium and vertebral column.](#)
- [The Largest Discovery of New Mammals in 90 Years Has Just Been Revealed.](#)
- Coprolites! [Fossil worm dung shows traces of microscopic 'miners' in elemental silver.](#)
- End Permian extinction: [Deadliest period in Earth's history was also the stinkiest.](#)

### **Landslides**

- From the [Landslide Blog: An update on the Mira Mar landslide in Albany, Australia](#); an entire neighbourhood in [Albany, Australia](#) is being destroyed by a landslide, apparently caused by groundwater.
- Also from the Landslide Blog, a lecture on slope stability: [The 11th Lumb Lecture at HKU: Bridging the Gap between Theoretical and Actual Slope Performance by H.N. Wong.](#)
- Also, if geotechnical engineering really interests you, you can listen to the [Breaking Ground Podcast](#).

### **Volcanoes**

- [Lethal pulsing inside pyroclastic surges.](#)
- [A Deadly Day on Mount Semeru.](#)
- [Scientists cautious as erupting Spanish volcano falls quiet.](#)
- I need to do this someday: [Beneath La Palma volcano, scientists collect lava 'to learn'.](#)

### **Earthquakes**

- [Evidence for shared earthquakes between San Andreas and San Jacinto faults.](#)

- [Dark fiber seismic network finds missed aftershocks in Chinese earthquake.](#)
- From the Guardian, so take it with a grain of salt: [The Big One: Canada floods show British Columbia is not ready for a powerful earthquake.](#)

## Energy

- [New view of deep rock fractures for geothermal energy.](#)

## Glaciers

- From the European Geosciences Union (EGU): [The EverDrill project: shedding light on the interior of a Himalayan debris-covered glacier.](#) Related: [Himalayan glaciers melting at 'exceptional rate'.](#)
- [Study of Antarctic ice's deep past shows it could be more vulnerable to warming.](#)
- [The threat from Thwaites: The retreat of Antarctica's riskiest glacier.](#)
- [Using the Earth's noise to see beneath the Greenland ice sheet.](#)

## Plate Tectonics and Mountain Building

- [Study combines climatic, tectonic models to explain Andean conundrum.](#)

## Lists of New Scientific Papers

- [GeoRoundup: the highlights of EGU Journals published during December!](#)

## For The Geologist In Your Life

- [Top 5 Gifts for Geoscientists \(2021 edition!\)](#)

## Upcoming Events



December 20, 2021

## Cambrian Period, Part 2

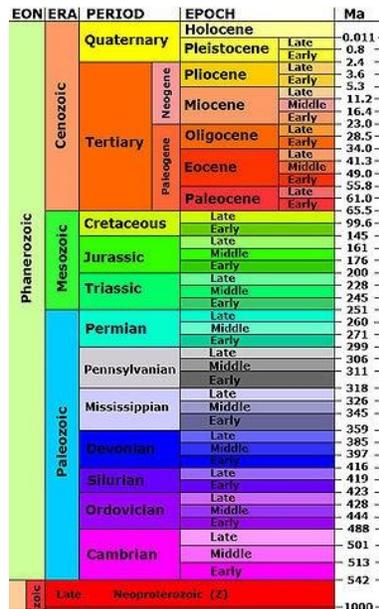


Figure 1 - Phanerozoic Time Scale

Credit: Modified from File: [Geologic time scale.jpg](#),  
[United States Geological Survey](#), public domain

We're going to look at a few subjects in this posting. We'll examine the nature of evolution, see how fossilization happens and looking at life during the Cambrian before taking a peak at the most spectacular fossil deposit from the Cambrian Period, the [Burgess Shale](#).

### The Nature of Evolution

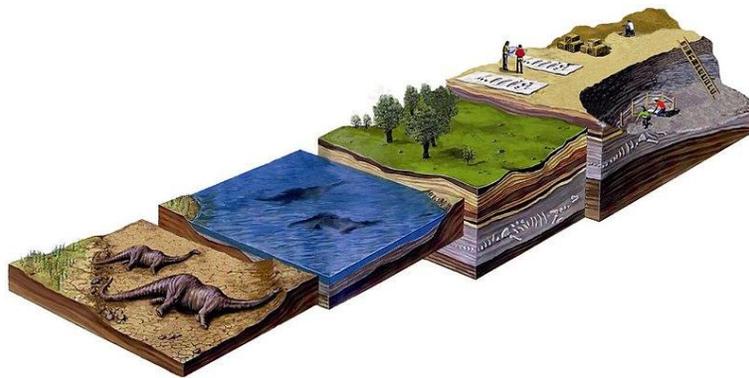
Evolution remains a difficult subject for many people. For some Christians, the findings of science contradict their understanding of Holy Scripture and many will thus reject any discussion of evolution except to deride it as false teaching. On the other hand, many people who accept evolution see it as an inevitable progress leading to humans, the ultimate expression evolutionary perfection. Science has thus been recruited to provide proof for the [Myth of Progress](#).

However, the Myth of Progress is no more scientific than biblical literalism and is considerably less honest. The Myth of Progress conflates a process for ascertaining facts about nature (science) with a secular religion (Progress). The Myth of Progress, among other things, is the notion that we can create heaven on earth and that the advance of science proves it. This is nothing more than [hubris](#). While the Myth of Progress may have had some utility as

propaganda for the project of industrial development, its fundamental dishonesty has no place in science.

The truth about evolution is that it is best understood as being the process by which life adapts in response to changing conditions and competition. First, there is always genetic variability and mutations are common enough to create that diversity. The evolutionary process is rough, those that can survive leave descendants, those that cannot, and they are in the majority, will die without issue. Evolutionary change is a response to whatever present conditions exist and has no inherent goal or future destination. The fossil record provides hard evidence that such change took place. The evidence suggests that we are no more highly evolved than all the other organisms we share this planet with. Also, note that it is in the nature of the fossil record that it can never be perfect or complete. Science can only approach the truth with available evidence, it should be used or be seen as a religion with "The Truth" ([ask Pontius Pilate](#)).

## Fossilization



**Figure 2 - Example of the Fossilization Process**

**Credit:** Xabier Murelaga [Creative Commons Attribution-Share Alike 3.0 Unported](#) license

The evidence for evolution comes from the fossil record. So how do living things leave fossils of themselves?

First, it is important to recognize that most organisms follow the ancient formula of dust to dust, ashes to ashes. Nature is extremely efficient at recycling living things. When most organisms die, their remains become food for another organism. So the preservation of any organism as a fossil is pretty rare.

The most common means of preservation of the remains of organisms involves rapid burial after death. The burial may be only of parts of the organism, such as the hard, indigestible bones and shells. In very rare cases the soft tissues may be preserved, such as when an insect is preserved in amber. Often what is preserved is not the original material, but an impression of the organism in soft clay as a cast. For hard parts, the minerals that make up the shells and bones

may be replaced by other minerals. Also, while the organism might be entirely lost, it may have left behind footprints, tracks, burrows or feces ([coprolites](#)).

While fossilization of any organism is rare, over the history of the Earth, enough fossils have been left behind to give us some idea of how life has changed over time

### **Life in the Cambrian Period**



**Figure 3 - Early Cambrian Trilobite from the Sinsk Formation, Yakutiya, Russia**  
**Credit: [Daderot, Creative Commons CC0 1.0 Universal Public Domain Dedication](#)**

The transition from the [Ediacaran biota](#) of the Neoproterozoic to the fauna of the early Cambrian was a rough one marked by a mass extinction. The Ediacaran organisms were adapted to living in a situation where the ocean floor was covered by a [microbial mat](#). The development of burrowing organisms had a [profound and irreversible effect on the substrate](#) resulting in the extinction of most of the Ediacaran organisms and the creation of new opportunities for the organisms that became dominant during the Cambrian.

Most fossils of animal life from the Cambrian Period are from marine organisms, mostly [arthropods](#). As well, most of the fossils from the Cambrian were of creatures that lived near the bottom of the ocean, with few fossils of creatures that lived higher up in the water column. The most common arthropod fossils from the Cambrian are [trilobites](#), although trilobites may only

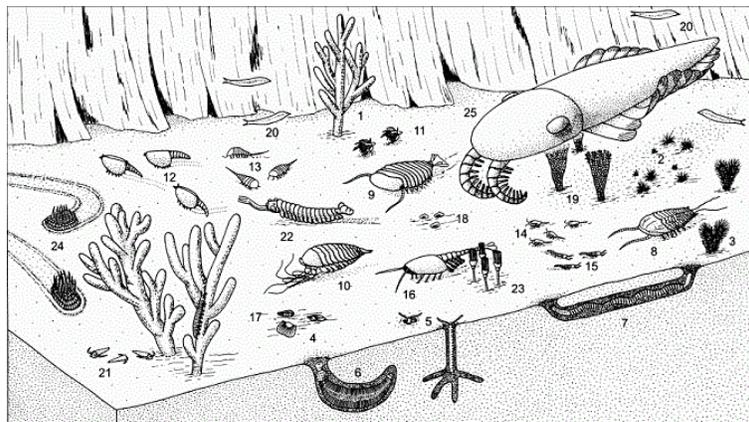
have been a minor part of the total arthropod diversity. Trilobites, however, had heavy exoskeletons that were easily fossilized.

The diversification of life during the Cambrian has often been called the [Cambrian Explosion](#). Almost all animals living today had ancestors that first appeared in the Cambrian although some, like sponges, appeared first in the Proterozoic and yet others, such as [bryozoans](#), which appeared in the Lower [Ordovician](#), did not appear later.

The trails of living organisms increased as the Cambrian Period went on. During the latter half of the Cambrian [stromatolites](#) became rarer and reef building sponges known as [Archaeocyatha](#) became more common. As well, 500 million years ago, oxygen levels fell dramatically in the oceans, leading to hypoxia. At the same time, levels of poisonous hydrogen sulfide simultaneously increased. These chemical changes caused the extinction of many organisms.

Animals first appeared on land during the Cambrian Period as shown in trace fossils of [Protichnites](#) and [Climactichnites](#). There is also evidence to suggest that [euthycarcinoids](#), an extinct group of arthropods, may also have been on the land.

## The Burgess Shale



Legend: sponges Vanuxia (1), Choia (2), Pirania (3); brachiopods Nisusia (4); polychaetes Burgessochaeta (5); priapulid worms Ottia (6), Louisella (7); trilobites Olenoides (8); other arthropods Sidneyia (9), Leanchoilia (10), Marella (11), Canadaspis (12), Molaria (13), Burgessia (14), Yohoia (15), Waptia (16), Aysheaia (17); molluscs Scenella (18); echinoderms Echinocrinus (19); chordates Pikaia (20); along with Haplophrentis (21), Opabina (22), lophophorate Dinomischus (23), proto-annelid Wiwaxia (24), and anomalocaridid Laggania cambria (25).

**Figure 4 - Burgess Shale Community**

**Credit: M. Alan Kazlev, Creative Commons CC0 1.0 Universal Public Domain Dedication**

We can't leave the Cambrian Period without at least a quick look at the Burgess Shale Formation. Located in [Yoho National Park](#), the Burgess Shale contains some of the best preserved fossils ever and are certainly the best preserved fossils from the Cambrian Period. The fossils record a catastrophic event during the Middle Cambrian when an underwater gravity flow or [turbidity current](#) caused the burial of a whole community of organisms. Let's look at some of these fantastic creatures.

## Anomalocaris



**Figure 5 - Fossil of *Anomalocaris***

**Credit:** Royal Ontario Museum, Toronto, [Creative Commons Attribution-Share Alike 3.0 License](#)

[Anomalocaris](#) was a predatory proto-arthropod that fed off of other wildlife. Its fossil was originally found in separate parts, leading to confusion about what it actually was. The remains shown in Figure 5 were the first complete fossil of the creature that were found. The name, *Anomalocaris*, means strange shrimp and refers to the fossil remains of the tentacles of the creature that resemble headless shrimp, which were among the first parts found as fossils.



**Figure 6 - Reconstruction of *Anomalocaris canadensis***

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

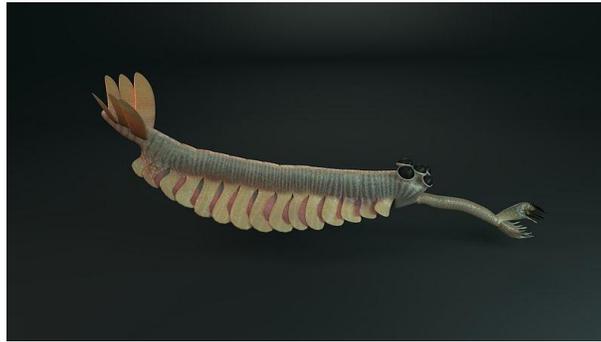
## Opabinia



**Figure 7 - Fossil of *Opabinia regalis***

**Credit:** [Jstuby](#), [public domain](#)

With five eyes, [Opabinia](#) was certainly a strange one. It was probably a predator that floated along the bottom of the sea, collecting tidbits as it went along.



**Figure 8 - Reconstruction of *Opabinia***

**Credit:** [Jose manuel canete](#), [Creative Commons Attribution-Share Alike 4.0 International license](#)

## Pikaia



**Figure 9 - Fossil of *Pikaia gracilens***

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

A [chordate](#), [Pikaia](#) is related to the ancestors of [vertebrates](#), including us. It was probably a free swimming creature that picked up food as it went along.



**Figure 10 - Reconstruction of *Pikaia***

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

Study of the Burgess Shale has generated dozens of books and scientific papers. Although it is a bit dated, a good introduction to the Burgess Shale is Gould, S. J., 1989, [Wonderful Life: The Burgess Shale and the Nature of History](#), W. W. Norton & Co., New York. Stephen Jay Gould was

a gifted writer and did much to popularize paleontology. Since the publication of *Wonderful Life*, new research into the Burgess Shale fossils has shown some of the stuff in the book to be mistaken, but it is still a good read.

### **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.