

## Advanced Reading About the Causes of the Cambrian Explosion

The earth is four-and-a-half billion years old. But it wasn't until 500 million years ago that animals evolved. The very first animals had evolved before the Cambrian. The "Explosion" during the Cambrian was really an explosion of the bilateral body plan. It was as if nature struck upon life's essential designs in a single evolutionary leap. Every new shape of life that has followed the Cambrian Explosion has been a variation on those basic designs. And, perhaps more remarkably, no new body plans have evolved since.

What caused this remarkable event in the history of life on earth? In 2016, the causes of the Cambrian Explosion are still the topic of scientific debate. Scientists do agree that there were probably both biological and non-biological causes interacting with each other.

One explanation is that suddenly, in the Cambrian, the genetic code became more complex. It could command and control the production of not just simple animals, such as sponges and jellies, but the more complex bilateral animals. This led to a rapid evolution of many new body plans in a short period of time.

A second explanation for the Cambrian Explosion may lie in a major shift in the nature of the planet itself, most likely in the oceans, which were home to all living things at the time. The most obvious of possible dramatic changes was a rise in oxygen levels. That would allow more complex, active animals that require more oxygen for their life style. In 2016, scientists are studying whether there was a change in oxygen levels at the start of the Cambrian.

A third explanation is that an evolutionary arms race began. Once animals had evolved movement and the power to hunt, prey animals evolved new ways to defend themselves. Prey became larger, with protective spines, or became faster and able to escape. Size is a great benefit for a predator. Perhaps nerves that enable sensing and the coordination of motion allowed the building of bigger, faster bodies that fed the arms race. Once a big, fast-swimming, deadly animal like *Anomalocaris* was on the scene, the drama of life took on a potential for sudden death that had been absent until that time.

During the Cambrian Explosion, the food web itself became complex enough to provide a multitude of possible ways to make a living. Out of this, an arms race for control of that food developed. As more and more animals evolved, that arms race intensified in the battles of the hunter and the hunted. Because there is an advantage in eating and avoiding being eaten, the arms race would never end. And the explosion of life was the response.

A fourth explanation is that a rapid rise in sea level in the early Cambrian flooded the land, causing erosion. This washed minerals into the sea increasing calcium (there was a threefold increase over previous levels) and phosphorus, making them more available to animals to build hard structures. Almost every animal group with hard parts made its first appearance in the Cambrian.

A final explanation is that starting in the Cambrian, animals began to tunnel vertically through the sea floor. Previously, animals had grazed only on the surface on a microbial mat. The burrowing animals opened new habitats allowing more variation of body forms to evolve to exploit the new habitats. Burrowing beneath the sea floor also made new nutrients available and provided new hiding places. The rise of these burrowing animals permanently altered the nature of the sea floor, an event commonly referred to as the “Cambrian Substrate Revolution”.