

Finding an answer to Darwin's Dilemma

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The sudden appearance of large animal fossils more than 500 million years ago – a problem that perplexed even Charles Darwin and is commonly known as "Darwin's Dilemma" – may be due to a huge increase of oxygen in the world's oceans, says Queen's paleontologist Guy Narbonne, an expert in the early evolution of animals and their ecosystems.

In 2002, Dr. Narbonne and his research team found the world's oldest complex life forms between layers of sandstone on the southeastern coast of Newfoundland. This pushed back the age of Earth's earliest known complex life to more than 575 million years ago, soon after the melting of the massive "snowball" glaciers. New findings reported today shed light on why, after three billion years of mostly single-celled evolution, these large animals suddenly appeared in the fossil record.

In a paper published on-line in *Science Express*, Dr. Narbonne's team argues that a huge increase in oxygen following the Gaskiers Glaciation 580 million years ago corresponds with the first appearance of large animal fossils on the Avalon Peninsula in Newfoundland.

Now for the first time, geochemical studies have determined the oxygen levels in the world's oceans at the time these sediments accumulated in Avalon. "Our studies show that the oldest sediments on the Avalon Peninsula, which completely lack animal fossils, were deposited during a time when there was little or no free oxygen in the world's oceans," says Dr. Narbonne. "Immediately after this ice age there is evidence for a huge increase in atmospheric oxygen to at least 15 per cent of modern

levels, and these sediments also contain evidence of the oldest large animal fossils."

Also on the research team are Don Canfield (University of Southern Denmark) and Simon Poulton (Newcastle University, U.K.). Geochemical studies by Drs. Canfield and Poulton included measurements of iron speciation and sulphur isotopes to determine the oxygen levels in the world's oceans at the time these sediments accumulated in Avalon.

The close connection between the first appearance of oxygenated conditions in the world's oceans and the first appearance of large animal fossils confirms the importance of oxygen as a trigger for the early evolution of animals, the researchers say. They hypothesize that melting glaciers increased the amount of nutrients in the ocean and led to a proliferation of single-celled organisms that liberated oxygen through photosynthesis. This began an evolutionary radiation that led to complex communities of filter-feeding animals, then mobile bilateral animals, and ultimately to the Cambrian "explosion" of skeletal animals 542 million years ago.

Source: Queen's University

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