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# Continental split boosted big mammals

**Atmospheric oxygen may account for popularity of placentas.**

Philip Ball

The formation of the Atlantic Ocean may be responsible for the fact that babies are attached to a placenta in the womb.

Growing a baby in the womb takes lots of energy - and lots of oxygen.



It sounds like a bizarre claim, but oceanographer Paul Falkowski of Rutgers University in New Jersey and his colleagues have discovered evidence for the link in the geological record.

They have found that the amount of oxygen in the Earth's atmosphere 200 million years ago was only about half what it is today. And the appearance of large placental mammals, around 50 million years ago, happened at the same time as the oxygen level more or less doubled[1].

This is also about the same time that the Atlantic Ocean opened up: a supercontinent split into the Americas, Africa and Eurasia, creating the ocean between them.

This continental movement created thousands of kilometres of coastline that helped to wash organic carbon into the sea, locking it away from the process of decay. Because such carbon escapes chemical processes that would turn it into carbon dioxide, the more carbon is washed away, the more oxygen remains in the atmosphere.

> **Nature is so damned complicated**
>
> Peter Ward
> University of Washington, Seattle

The authors of the *Science* paper say their work highlights the intimate connections between geology and biological evolution, illustrating how life on Earth has been shaped in surprising ways.

**Rocky road**

The proportion of oxygen in the Earth's atmosphere has varied considerably over time. Falkowski's colleague, geologist Robert Berner of Yale University, Connecticut, has previously shown that these changes can be read from the geological record by looking at carbon isotopes. These atomic forms of carbon with different weights are locked up in carbon-rich rocks and their ratio gives indirect clues to past atmospheric composition.

The ratio is altered by how much organic material is washed away and incorporated into rock on the sea floor, along with other factors such as volcanic eruptions. Turning data about carbon into a record of atmospheric oxygen involves some complex modelling. "It's a very tricky thing to do," says Peter Ward, a palaeontologist at the University of Washington in Seattle. But it can be done

Falkowski, Berner and their colleagues have taken a detailed look at the past 200 million years by measuring carbon-isotope ratios in sedimentary rocks at the bottom of the Atlantic Ocean.

They find that there was far less oxygen in the atmosphere (about 10%) at the start of the Jurassic period, some 200 million years ago. The amount fluctuated considerably over the next 60 million years, levelled off at 15-18% during the Cretaceous period (between 144 million and 65 million years ago), and then rose abruptly to about 23% in the early Eocene epoch, 50 million years ago. Today, oxygen levels have settled at 21%.

**Rich airs**

Placental mammals began to appear at the end of the Cretaceous, but they were small, rodent-sized creatures. "We don't really see large mammals until the Eocene," says Falkowski.

This, he suggests, was made possible by the sudden oxygen rise at that time. Large mammals have a lower density of capillaries than small mammals, so they can only distribute oxygen around their bodies efficiently if there is a lot of oxygen in the air. Placental reproduction also needs a lot of ambient oxygen, because only a small proportion of that in the mother's blood reaches the fetus.

Falkowski adds that high oxygen levels may have also triggered an expansion in brain size: it may have helped mammals get smarter.

Oxygen hikes have been linked to animal evolution before. Some 300 million years ago, for example, oxygen levels are thought to have soared to as much as 35%. This period abounded with monstrous amphibians 5 metres long and dragonflies the size of hawks.

"Changes in oxygen may have been a huge driver for mammalian evolution," Ward agrees. But it isn't yet clear whether it was the biggest factor in the rise of large placental mammals. "Nature is so damned complicated," he warns.

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## References

1. Falkowski P.G., *et al*. *Science*, **309**. 2202 - 2204 (2005).

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