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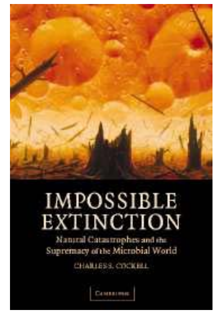
***Impossible extinction** – natural catastrophes and the supremacy of the microbial world*, by Charles S. Cockell, 2003. Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, United Kingdom. Hardback, x + 181 pages, 27 figures, 11 plates. Price GBP 25.00; USD 45.00. ISBN 9780521817363.



Only rarely a book is published in a specific field of science that is (also) of great interest to researchers in other disciplines (in this case, the earth sciences). This book is one of them. It deels with microbes (in the broadest sense), their history on Earth, their possible distribution in the universe, and their great ability to survive catastrophes that make many other organisms extinct.

The author, Charles Cockell, is a microbiologist, working with both the British Antarctic Survey and the Search for Extraterrestrial Intelligence Institute at the NASA Ames Research Center. Apart from being a scientist, he has been Science Correspondent for the Oxford Times for three years, and this explains his style of writing: easy to read, taking material from a lot of sources, and not afraid of putting own ideas forward. This is exactly what makes this book pleasant reading.

The title of the book is intriguing, and it takes some time before the reader becomes aware of its meaning. Cockell states that microbes will survive on Earth, whatever catastrophes happen and whatever mass extinctions may occur, until the Sun will come – in some 5 billion years – to the end of its life cycle, expand, resulting in boiling of the oceans, melting of the rocks and ultimately evaporation of the entire earth. Before this unavoidable end of the Earth, our solar system will make a long voyage through space, circling some 20-25 times around our galaxy. It is time and time again this ‘orbit’ around the galaxy that Cockell mentions, emphasizing that during such a 225 million year orbit the Earth will be subject to many dangers, and that mass extinctions may result. However intriguing this approach may be in theory, Cockell does, unfortunately, not work it out at all. In fact, he describes some ‘cosmic catastrophes’ that we are already well aware of (impacts of bolides, supernova explosions) and he also adds some catastrophic events (such as the formation of the Deccan Traps and the Siberian Traps) that may or may not be related to impacts, but that most probably contributed to the contemporaneous mass extinctions. And, indeed, he makes very clear why microbes could survive while so many other species became extinct.

This all takes, in my opinion, much more space than really necessary, but the book is nevertheless pleasant reading and never dull. It starts with a first chapter (The galactic roulette) that is a short introduction into astronomy. Chapter 2 (Primordial leftovers) deals with Earth as part of our solar system and of our galaxy. It emphasises that Earth would not have been able to develop life as it is now without its neighbours. Were you aware, for instance, that the large mass of Jupiter attracts so many bolides that approach our solar system from space that planets like the Earth are fairly effectively protected from a continuous rain of bolides that might make our planet inhabitable? Chapter 3 (The microbial menagerie) then provides a wealth of data about microbes. It deals with the conditions that make Earth a habitable planet, the methods to trace life in very old rocks, etc. And, again, there are a lot of interesting data. Did you know that microbes were abundant in early Earth history when the CO_2 pressure was 2000 times the present one, and the ultraviolet radiation 1000 times? Did you know that the Titanic is literally eaten away at the seafloor by microbes; that microbes make up more than 80% of all biomass; that they occur in the Earth's subsoil up to some 6 km deep, in the atmosphere up to some 70 km high, in hot vents of 113 °C; and that microbes take some 140 million tonnes of nitrogen from the atmosphere annually, converting it in chemical forms that can be used by other organisms? The chapter is full with this type of data and easily convinces the reader of the extraordinary significance of microbes.

Chapter 4 (The record of catastrophe) mentions some of the catastrophes that Earth faced. These have led to mass extinctions, which explains part of the evolutionary development of life on Earth. Cockell estimates that some 5-50 billion (10^9) species have lived on Earth, but that only some 250,000 fossil species are known, so that our knowledge of fossil life is very fragmentary only. Our limited knowledge of previous life is mostly due to the fact that microbes are not easily detected in ancient rocks, but also to the fact that numerous types of microbes have hardly any preservation potential, partly because of the environmental conditions they live in, partly due to the lack of skeletons. Many microbes must, however, have become extinct during the voyage of Earth through space, but they survived much better than any other group of organisms, thanks to the fact that so many microbes live under extreme conditions. In the next chapter (The sky falls in), some of the frequencies of catastrophes are estimated. An impact like the one that caused the mass extinction at the K/T boundary may happen some two times during one orbit of our solar system around the galaxy, and an impact such as the one that created the Banninger crater in Arizona is to be expected some 25,000 times during such an orbit. An 'almost impact' with a huge explosion in the atmosphere like the 1918 one in Siberia (Tunguska) probably happens once every 100-1000 years [Cockell warns correctly that not all layers with iridium concentrations should be taken as proof for impact of an extraterrestrial body, as some volcanoes – like the Kilauea on Hawaii – emit relatively large amounts). All such impacts, however devastating, are, however, uncapable of making all microbes on Earth extinct: the effects of the impact do not affect many of their habitats. This is also true for another potential catastrophe: the explosion of a supernova (Chapter 6: Supernova fry up). If such a supernova explosion occurs within a distance of 35 light years (which is estimated to happen once every 50-700 million years), the resulting radiation may destroy the ozone layer for some centuries, what will result in large-scale damage of the DNA of all kinds of organisms. But Cockell remains optimistic: microbes will survive anyway, and even for more complex organisms the long-lasting exposure to ultraviolet radiation may have beneficial evolutionary effects.

Chapter 7 (Fire from below) is not reaaly about catastrophes related to Earth's voyage through space. The volcanism dealt with here is, however, compared with some extraterrestrial volcanism, in particular on Mars, where the largest volcano reaches a height of 21 km. Cockell's explanation for this much higher extent of the Mars volcanoes (lack of recent plate tectonics) is certainly not convincing. More interesting are his remarks about primitive life in hot pools; in Yellowstone Park, for instance, hundreds of species are present in individual pools that have temperatures up to 95 °C (whereas multicellar organisms never have found on Earth living at temperatures above 55 °C): another proof that microbes can survive conditions that are deadly for more complex organisms.

The influence of Man is dealt with in Chapter 8 (Intelligent stupidity). Man cannot be considered a universal threat, but certainly a threat for Earth, and he must be held at least partly responsible for the extinction of some 30,000 species annually. This might not a problem in itself, as many new species appear, but it are particularly the large animals that Man makes disappear, so that ecosystems and food chains become destroyed. The extinction caused by Man is largely due to the population explosion, changing previously favourable habitats into places where only microbes do well (such as waste dumps). In this context Cockell mentions the problem of nuclear waste, but also refers to the natural reactors that operated in Gabon some 1.5 billion years ago without any apparent consequences for microbial life. The last chapter (9: The world is not enough?) could be considered as some kind of summary. It introduces the reader also into the search for extraterrestrial life, and into the best methods to detect it, on the basis of what we know about microbes on Earth.

A glossary and a useful index are useful additions to this book that brings a lot of information for earth scientists, and that is certainly worth reading. Unfortunately, however, Cockell apparently has opted for a well-readable book at the cost of scientific thoroughness. It is obvious that he has a giant knowledge of microbiology, but his geological explanations and terminology are not always sound. He does not know the difference between magma and lava, he provides fairly old (and incorrect) information (e.g. the beginning of the Phanerozoic at 600 Ma ago), and his explanation of uniformitarism is entirely wrong. More examples will be easily found by readers with an earth-scientific background. His story about the natural reactors in Gabon contains numerous mistakes (“Gabon is home to rich seams of uranium ore laid down when the Earth formed 4.5 billion years ago”: p. 147); “the rocks also contained large quantities of fission waste products such as plutonium-239": p. 149 – in fact, all plutonium has already disappeared by natural decay). In addition, Cockell is wrong in the physical aspects stating that “The water ... acted as a nuclear moderator, reflecting the neutrons into the reactor core” (p. 149), whereas the water in a nuclear reactor acts (as a moderator) to slow down the neutrons (because they would not induce new fissions otherwise), and neglecting that a natural reactor has no reactor core. The advice to Cockell should therefore be: keep to your own discipline!

Such mistakes should be corrected in a new edition (and the book itself is worth a new edition). In a new edition, most of the figures should also be replaced. Their quality is often so low that they cannot be really deciphered, and Cambridge University Press should never have accepted such quality. In addition, the book is full of typos, which could, of course, have been avoided if the proofs had been read carefully. Apparently neither the author, nor the publisher did so. A shame!

All together, this brings me to the conclusion that the book is highly interesting, particularly for those who have to do with early life, with microbial paleontology, with extremophiles or with present-day ecology, but that the book has unduly many shortcomings where it comes to details outside the author’s specialism, and where the quality of the presentation is concerned.

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