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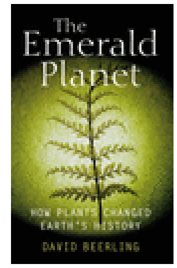
The Emerald Planet – How Plants Changed Earth's History, by David Beerling, 2007. Oxford University Press, Great Clarendon Street, Oxford, OX2 6DP, United Kingdom. Hardback, xvi + 288 pages. Price GBP 14.99. ISBN 978-0-19-280602-4.



A green colour, due to a plant carpet covering the land, makes our planet special. Someone with good eyes may call this colour “emerald”, but such a detail is really insignificant. Undoubtedly, plants played an important role in the evolution of the Earth. For instance, they might have been the organisms that were responsible for the rise in atmorpheric oxygen at the end of the Proterozoic (Heckman et al., 2001), which permitted further radiation of plants themselves, but also of animals and, later, humans. So much has been written on the floristic evolution, but so little is still known on its relationships with the entire geological history of the Earth. Numerous intriguing studies by biologists are not known to geologists, and a number of new geochemical models account for neither particular patterns of plant physiology and ecology, nor evidences from their fossil record. It seems therefore time to start a complex, multidisciplinary analysis of all available knowledge concerning this topic. This might yield some interesting and surprising conclusions about the Earth’s past. As ecologists care so much for the recent decline in forests and for climate change, the results from such an analysis would help them to better understand our present-day world and to make some valuable predictions of its further development.

David Beerling, a brilliant English specialist, has written a book that might be considered already as such a multidisciplinary analysis of plant evolution. I feel that the main purpose of his book is to share a number of “fresh” ideas on how to integrate the knowledge on plants with that on the geochemical and paleoenvironmental history of the Earth throughout the Phanerozoic.The concept of the book is both simple and complex. Its simplicity is in the combination of a number of selected stories, in popular wording and enlighted by a truly informative historical background (Beerling underlines the importance of knowledge of the history of science). These stories have, however, obviously been selected so as to approach a number of complex problems, the solution of which requires a good understanding of biological, physical, chemical, and, not in the least, geological phenomena. In other words, Beerling has undertaken a very difficult task, but he managed very well.

Apart from a Preface, Acknowledgements, Illustrations and plates (image credits), the book comprises 9 main chapters, followed by Notes and an Index. The chapters are organized in a logical order. Moreover, the author has attempted to place them in a chronological order, which is explained in his Figure 1 (p. 6).

Chapter 1 (Introduction) explains briefly the general idea, concept, and style of the book, and it also suggests integration of knowledge as one of the most important objectives of the author.

Chapter 2 (Leaves, genes, and greenhouse gases) bridges palaeobotany with plant physiology and palaeoecology, and details their role in the regulation of the atmosperic composition. Special attention is paid to the earliest plants, including *Cooksonia*. The delay in the appearance of plants with leaves is tentatively explained as well; some knowledge of genetics is used for this explanation. The expansion of terrestrial floras might have occurred thanks to an increase in atmospheric oxygen, but plants themselves were responsible for this increase! The author considers the possibility that plants were genetically ready to radiate, but just had to wait for a sufficient change in the atmospheric composition.

Chapter 3 (Oxygen and the lost world of giants) explores how the changes in oxygen content enforced the biotic evolution. In particular, the rise in oxygen might have been responsible for giantism. A large part of this chapter is devoted to the discovery of oxygen and reconstructions of its changes in atmospheric concentrations throughout geologic time. Although there are some good descriptions of giant taxa, the readers would like to find more on this subject.

Chapter 4 (An ancient ozone catastrophe?) tells about the ozone hole (an icon for ecologists!). Beerling suggests the possibility that massive volcanic eruptions or extraterrestrial impacts were able to generate similar ozone holes in the Earth's past as we witness nowadays. This might help to explain the Permian/Triassic mass extinction, which devastated the planetary biota, because a destruction of the ozone layer would imply strongly increased exposure of the biosphere to ultraviolet radiation. It appears that the already-recorded mutation of plant spores correspond to such an effect. Well, this is a surprising hypothesis. In my opinion, it is of crucial importance in this context to obtain very accurate absolute dates for the eruption of the volcanoes that led to the Siberian trap basalts. Perhaps plants may help to do so?!

In Chapter 5 (Global warming ushers in the dinosaur era), an attempt is made to unravel possible relationships between plant evolution, global environmental perturbations, and greenhouse gases. The author takes the mass extinction at the Triassic/Jurassic boundary as an example. This is a bit surprising, as it is still not really clear whether the Triassic/Jurassic crisis was a global event, whether it was an abrupt catastrophe, and whether it occurred precisely at this boundary, indeed (Hallam, 2002). Beerling outlines that plants document the palaeoenvironmental changes at the time of this crisis very well, and he examines a number of possible explanations for these changes. Massive eruptions in the Central Atlantic Magmatic Province, together with methane release from the ocean floor, might have been its important triggers. In my opinion, however, the causes of this mass extinction (and all others) are still insufficiently understood, and it even remains unclear as yet whether they actually occurred at all!

Chapter 6 (The flourishing forests of Antarctica) is devoted to polar forests. It deals with both fossil forests discovered in the present-day polar regions and forests that grew in the anceint polar regions. It was already known that it was warm enough for forests during some time-spans of the Earth's past to develop in near-pole regions. This might well have influenced the carbon cycle. An important question is why the forests of the northern hemisphere were mostly deciduous. One possible explanation involves a difference in strategies between deciduous and evergreen forests (fast-growing versus slow-growing) and frequent fires in the polar regions. Other hypotheses focus on the temperature of the soils or on the release of soil nutrients.

In Chapter 7 (Paradise lost), it is emphasized that not only carbon dioxide, but also methane is an important greenhouse gas. An increase in its content in the atmosphere could explain the Eocene climatic maximum. Computer-based Earth climate simulations described in this chapter contribute to the understanding of what actually is a “greenhouse world”.

Chapter 8 (Nature’s green revolution) gives some clarification to the extension of grasslands, which occurred in the late Cenozoic. C_4 plants spread in addition to the pre-existing C_3 plants. According to Beerling, not only a “carbon dioxide starvation”, but also a self-reinforcing fire might have been the trigger of such a change in the world ecosystems. The latter hypothesis is supported by recent observations of C_4-plant colonization of Hawaii and New Caledonia. The human-induced deforestation nowadays strengthens the spreading of C_4 plants.

Chapter 9 (Through a glass darkly) deals with two subjects: (1) the implication of knowledge presented above to document, date, and explain the events in the planet’s history, and (2) plants as a geological agent. A number of intriguing examples are given. The shape of leaves (toothed shapes are more typical of colder climates) and frost intolerance (an increase in plant susceptibility to freezing occurs together with a rise in the atmospheric content of carbon dioxide) provide new tools to explore paleoenvironments. It is emphasized that plants were significant regulators of the latter. In the warm Cretaceous world, for instance, the polar forests were able to affect the atmospheric circulation, because, particularly, they darkened the land surface. Someone may find such ideas “exotic” and, thus, unrealistic, but our knowledge is still too limited to have a clear insight into which hypothesis is right and which must be wrong. The suggestions of Beerling are supported by trustworthy observations and, consequently, all of them should be considered seriously.

Each chapter of this book starts with a small but pretty summary, which helps to understand the author's ideas and their interrelationships. In addition, each chapter is accompanied by a quote from the classics, both scientists (like Charles Lyell and Niels Bohr) and others (like George Sand). This is a splendid decoration of the book.

This book is not aimed as a textbook, but rather as general reading. In his introductory remarks, the author underlines that he simply tells the stories. This explains the absence of a list of references and the presence of a lengthy section named “Notes”. Just imagine: it counts 60 pages! The notes are grouped by chapter and their numbers are mentioned in the main text. Numerous references are mentioned here and there, but they are not presented in an alphabetical order. I strongly doubt whether such an organization is useful and helpful. To search for a particular comment (a tremendous task: their total number exceeds 650!) is a highly unpleasant interruption of the reading. Searching for a comment takes so much time that one easily forgets what one was reading. Moreover, the absence of references does not allow to find out precisely what ideas and sources were used by the author. I am curious, for instance, whether Beerling mentioned the idea of molecular clocks. Do I need to read through 60 pages of text typed in a smaller letter size to find out? Another example: the author often refers to works by R. Berner from Yale University. Now I wonder whether the book reviewed here was written before or after the publication of the latest review of the carbon and oxygen histories by Berner (2006)? In other words, is this review cited by Beerling? It looks whether somebody (maybe not Beerling himself?) already decided what I need to find in this book, where and how. It would have been much more convenient for the reader if the notes and comments were presented at the bottom of each page, and if relevant citations were made in the text that could be traced in an alphabetical reference list.

It is difficult to judge how well this book is illustrated. Two kind of illustrations are included: figures and plates. The latters are grouped in a special section in the middle of the book. All images are black-and-white and commonly moderate to small in size. Are 13 figures and 16 plates enough for a 300-page volume? If somebody prefers richly-illustrated books, he will find this book poorly illustrated. On other hand, all figures and plates are relevant and informative. Well, they do not dominate the book, but this gives us the opportunity to enjoy the pure reading. A problem, however, is the absence of references in the figure captions. It’s true, the credits for images are listed thoroughly in a special section (pp. xiv-xvi), but sometimes it is convenient to find them directly in the captions. Figure 10 (p. 148), for instance, presents a picture of the Cenozoic climate. For me, it was easy to recognize that it was reproduced from the famous work of Zachos et al. (2001), but I'm not sure that all potential readers will know this.

The subject index is detailed and useful. It includes terms, relevant persons, and a few geographical localities. It also deals with the scientific institutions mentioned in the text, which is unusual, but useful.

In my opinion, this is truly an important book. The author’s style is attractive and the text is easy to understand. Really new ideas are considered and really new concepts are put forward (even many more than I could possibly mention in this review). The author continuously attempts to bridge the past to the present and to the future. The historical background is really rich. I like this book also because the author does not restrict his conclusions to facts and well-known concepts only. He is free in his thinking and operates with a number of hypotheses. This book will be interesting for a wide spectrum of geoscientists, including specialists in paleoenvironmental reconstructions and geochemistry, paleoclimatologists, and, undoubtedly, paleobotanists. Ecologists will enjoy it most of all.

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