BOOKS: PALEOBIOLOGY

Reef Processes in the Long View

J. E. N. Veron

In *Reef Evolution*, Rachel Wood takes on the difficult task of combining two traditionally isolated scientific realms, geology and biology. The outcome will impress different readers in different ways. As is inevitable with such a multidisciplinary subject, individual readers are likely to conclude that the author knows a lot about the subject in general, but is not up to speed in their own field, whatever that field may happen to be.

Reef Evolution
by Rachel Wood

Oxford University Press, Oxford, 1999. 426 pp. $100, £55. ISBN 0-19-854999-7. Paper, $37.50, £22.50. ISBN 0-19-857784-2.

Wood notes that "the theme of this book is to reinterpret the evolution of reefs from a biological perspective." Yet the book is overwhelmingly geological in perspective; it is written by a geologist who reaches for biology as opportunity allows. Even with the word "evolution" in the title she tries to do this. Most biologists think that organisms evolve, but reefs, like mountains, do not. Semantics aside, most readers will hope the book serves at least one of the following purposes: that it be an encyclopedia about reefs; that it be a synthesis of knowledge; or that it launches a new theory or presents an original perspective.

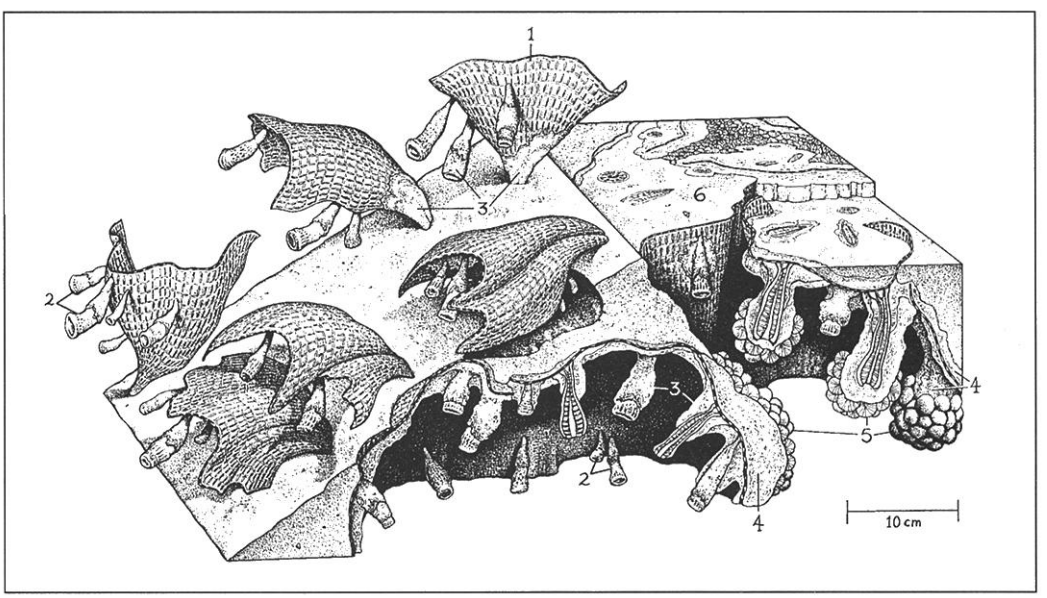
As an encyclopedia, *Reef Evolution* is useful, but primarily for geological subjects. Reef biology is a recent and rapidly expanding subject: references over a decade old are now largely superseded and debates over most of the central theories remain unresolved. With regard to the latter, it is hard for any writer to cope with these many points of view. Nevertheless, Wood has reviewed a wide range of biological subjects with vigor, and it is a reflection on reef biologists that she has had to complete so much original review-level work herself.

As a synthesis of knowledge from a primarily geological perspective, the book is an admirable effort. Although much of the subject matter is treated in more detail, or more "biologically," in other reviews, *Reef Evolution* is a mine of information for all who study coral reefs. Even so, perhaps because the book is strongly process oriented, there are some surprising gaps. For example, if evolution means change over time, many readers will search in vain for a detailed account of the impact of Pleistocene sea-level changes in the shallow seas of the central Indo-Pacific—a catastrophic time for one-third of the world's coral reefs. Similarly, no classification of reef morphologies—again products of evolutionary change over time—is proposed. We are left with a brief sketch of Darwin's original groupings (atolls, barrier reefs, fringing reefs, and patch reefs). Perhaps most surprising is the overall lack of geographic information: no paleogeographic reconstructions, no paleobiogeography, in fact no biogeography at all. Although reef biologists are at least aware of the links between the patterns and processes of such topics, the author has steered clear of discussing them.

Original perspectives? Apart from the proposals that the acquisition of photosymbiosis and the appearance of modern predator groups are "relatively recent" geological occurrences, no major original theories emerge. Even so, this first proposal is not well supported and readers are unlikely to be persuaded that the Scleractinia have not been photosymbiotic since they started building reefs. Furthermore, Wood's own data compilations generally argue that Paleozoic corals (or at least the Rugosa) and the Scleractinia have comparable variations in growth form and even growth rate, more evidence supporting the antiquity of photosymbiosis. The section on mass extinctions will be of broad interest and is a useful synopsis of a field that is currently attracting a lot of attention.

One perspective, for want of a broader word, is definitely original. As Wood says, ancient reefs are too often studied as solely geological phenomena. *Reef Evolution* is certain to do a lot to rectify that; it will encourage paleontologists to extrapolate from our knowledge of the modern to our reconstructions of the past. This is something that most paleontologists imagine they do well but in fact do not. The reverse is even more true. For most biologists, "ancient" means dead and boring and "millions of years before present" means time out of mind. If biologists find this book somewhat "idiosyncratic," as Wood herself suspects, they would do well to reflect on their own understanding of geological time and what all those noughts actually imply.

The book is easily read and delightfully free of technical jargon, a necessary attribute of an interdisciplinary production. It is set out in three parts: "Introduction to reefs both ancient and modern" is almost entirely about ancient reefs. "Environmen-



Cavity life. Wood's reconstruction of the bryozoan-sponge community of the Upper Permian Capitan Reef (west Texas): 1, frondose bryozoans (*Polypora*, *Goniopora*); 2, solitary sphinctozoan sponges; 3, *Archaeolithoporella* (encrusting ?algae); 4, microbial micrite; 5, cement botryoids; 6, sediment (grainstone-packstone).

CREDIT: JOHN SIBBECK/FROM *REEF EVOLUTION*

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tal controls" has chapters on physicochemical change (a major theme of the book as a whole) and mass extinctions. "Evolutionary innovation" mixes geological and biological perspectives; here individual readers will have individual responses. Specialists will probably grumble about the treatment of their subject, but will likely find the whole interesting.

The index is sometimes wanting, which is a shame because it restricts easy access to information. "Evolution" is not in the index, and if readers want to find out about diversity (or biodiversity) or the K-T boundary they will have to go searching. The glossary is good, and the breadth of literature reviewed is excellent. Reviewers traditionally note typos and the like, but my only such find is that in the appendix, in which the geological timescale is printed, the pages have been reversed.

The bottom line is that *Reef Evolution* is a scholarly production that carries both authority and credibility. With such a wide range of closely interlinked subjects, it must have been a difficult book to write and would itself have surely evolved in the writing. The result should be applauded by all who study reefs; it is destined to have a substantial impact on reef biology and geology alike.

BOOKS: EPIDEMIOLOGY

Solving the Sverdlovsk Mystery

Jonathan B. Tucker

In April and May 1979, an unusual epidemic of human anthrax occurred in the Soviet city of Sverdlovsk. Over a seven-week period, the disease sickened 96 people, of whom 64 died. Soviet authorities claimed that the outbreak had resulted from the consumption of beef contaminated with anthrax bacteria, but U.S. officials suspected that the real cause was an accidental release of anthrax spores from a nearby biological weapons facility. Matthew Meselson, a Harvard biochemist with a long-standing interest in biological weapons policy, initially accepted the tainted-meat theory offered by the Soviets. Lingering doubts remained in Meselson's mind, however, and in 1992, after the breakup of the Soviet Union, he arranged for a team of American scientists to visit Sverdlovsk (now Yekaterinburg) and investigate the anthrax outbreak 13 years after the fact.

Anthrax is a detailed description of that investigation, which involved a great deal of "shoe-leather epidemiology," the labor-intensive collection of data in the field. The story is told in the first person by Meselson's wife Jeanne Guillemin, a sociologist who interviewed the families of the anthrax victims. Although the book does not shed new light on the findings of the investigation, which Meselson and his colleagues published in November 1994 (*Science* **266**, 1202), it does provide interesting insights into the methodology and challenges of epidemiological field research—especially when the party being inspected has something to hide.

Anthrax
The Investigation of a Deadly Outbreak
by Jeanne Guillemin
University of California Press, Berkeley, 1999. 339 pp. $27.50. ISBN 0-520-22204-0.

Despite several false leads and the deliberate destruction of evidence by the Soviet authorities, the Meselson team managed to collect some useful data. Autopsy specimens, hidden by a courageous local pathologist in defiance of KGB attempts at confiscation, suggested that most of the victims had died from inhaling anthrax spores rather than from ingesting contaminated meat, but the findings were not conclusive. To confirm the source of infection, Guillemin interviewed surviving family members to determine the victims' locations in the days and nights just before the epidemic, and plotted the data on a map of Sverdlovsk. Although the nighttime locations were scattered, the daytime locations were clustered in a narrow band southeast of a secret military complex called Compound 19. Guillemin writes that when she saw the dots converging into a meaningful pattern, the hair went up on the back of her neck.

Meteorological data obtained by Meselson revealed that the band of cases paralleled the prevailing wind direction on 2 April 1979, but on no other day in late March or early April. Lying along the same axis were six villages up to 50 kilometers southeast of Sverdlovsk where sheep and cattle had caught anthrax. These findings suggested that on 2 April a suspected biological weapons facility in Compound 19 had accidentally released an aerosol of anthrax spores that traveled downwind in an elongated plume, infected human victims southeast of the facility, and continued into the countryside to sicken livestock. Had the prevailing winds on 2 April blown north over the densely populated city center, the death toll would have been far greater.

Downwind deaths. Grave marker photographs of 2 of the 64 people killed in the 1979 anthrax epidemic in Sverdlovsk.

Anthrax combines a personal memoir, a medical detective story in the tradition of Berton Roueché, and a sociology text with scholarly references—three genres that coexist awkwardly at times. But Guillemin effectively portrays the subjective side of scientific research, describing her feelings of confusion, frustration, and doubt at various points in the investigation. Even when the pieces of the puzzle finally fall into place, her joy of discovery is tinged with a melancholy awareness of the terrible human costs of the epidemic.

For Guillemin the sociologist, the Sverdlovsk outbreak is "as much about morality and political accountability as science." She notes that despite the compelling evidence for an accidental release of anthrax spores from a bioweapons plant, senior Russian officials have clung to the discredited tainted-meat theory and the victims' families have never been compensated. Moscow's refusal to accept responsibility for the Sverdlovsk disaster, she contends, bodes ill for the future of democratic reform in Russia.

On a more positive note, *Anthrax* demonstrates that systematic epidemiological investigation can ferret out the cause of an unusual disease outbreak, even after a hiatus of 13 years and in the face of an official cover-up. Although the increasing mobility of the Russian population would complicate such a study today, the Sverdlovsk case provides a valuable model for a proposed system of field investigations, currently under negotiation in Geneva, that would strengthen the 1972 Biological Weapons Convention by detecting—and thereby deterring—the covert use of anthrax and other biowarfare agents.

CREDIT: LEFT, JEANNE GUILLEMIN; RIGHT, MARTIN HUGH-JONES/FROM *ANTHRAX*

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