told that sodium chloride is salt, and that sand is SiO_2, will not get much enlightenment from such phrases as "ATP is an example which can be detected in minute amounts by the luminescence it produces with the firefly luciferin system". There is no reason, in a book such as this, to name all those who first made various suggestions —especially suggestions that, by hindsight, seem pretty obvious. But if attribution is being made, it should be correct. Here it often is not: for example, on extra-terrestrial courses for terrestrial life, on the possible artificiality of the martial satellites, and on the possibility of organisms dependent on a biochemistry fundamentally different from the familiar one.

So much for criticism. The book has two outstanding merits. It is broadminded, and it looks interesting because of lavish and relevant illustration. Stress is laid on the diverse conditions in which microorganisms thrive. They are found in all the extensive environments where there is an energy flux or where there is a metastable chemical state that they can exploit by bringing it into equilibrium. An organism would get no evolutionary advantage from being adapted to an environment that does not exist in nature. But, on present evidence, there is no reason to assume that, given a few million years for adaptation, organisms would not be able to adapt to even more extreme conditions than those in which we find them. In the prebiotic era there was probably little or no ozone in the atmosphere, and it is often suggested that eobionts would have had difficulty contending with the consequent intense ultraviolet light—on the contrary, they probably used it. Microorganisms seem not yet to have adapted so as to use the radiation in the cooling water of nuclear reactors, but they are already causing trouble there.

There is no trace here of the parochial outlook that leads many biochemists to regard the search for life elsewhere as a mere matter of designing a gadget to detect ATP, nucleic acid or protein. That type of evidence works one way: the presence of such substances would suggest the presence of organisms, absence would mean nothing. A short section of the book deals with the potentialities of substances such as ammonia, hydrogen sulphide, germanium and silicon as the dominant vehicles of xenobiotic life.

Tesla thought he had detected extraterrestrial radio messages and the idea was used by H. G. Wells in the epilogue to *The First Men in the Moon*. We are now reasonably certain that no interpretable messages are coming from other members of the solar system. Sneath has an interesting section on the subjects that might be dealt with in more desultory conversation that might be conducted with more distant bodies. He is again pleasingly unparochial. It is reasonable to assume that any community able to send and receive radio messages will be numerate. The conversation might therefore start with things like the sequence of prime numbers so as to establish our intellectual credentials. The next topic is more puzzling. It seems unlikely that there will be much interstellar communication until we have managed a meaningful dialogue with the more intelligent of our neighbours, for example elephants and dolphins, with whom we share an environment that can be discussed. It is a logical consequence of the Copernican revolution that, if we are not alone in the universe, any other community is as likely as not to be millennia ahead of us. If its members have not come here, it is unlikely that we will be able, or be permitted, to go there. Physical contact is therefore improbable in the foreseeable future.

Although an attentive reader of popular scientific literature will not find anything very novel in this book, the material is attractively laid out. In science, as elsewhere, assumptions have to be made. They do not become obstacles to progress if it is clearly recognized that they are assumptions. Sneath makes his way skilfully through a labyrinth of fact, fancy and assumption. N. W. PIRIE

TIMES PAST

Toward a History of Geology

Edited by Cecil J. Schneer. (Proceedings of the New Hampshire Disciplinary Conference on the History of Geology, September 1967.) Pp. vi+469. (MIT Press: Cambridge, Massachusetts, and London, April 1970.) 210*s*.

THIS is a collection of twenty-six papers presented at the New Hampshire Conference on the History of Geology in September 1967. They are written by leading world authorities on the subject and deal especially with those aspects which form a part of the general history of science, probing into the mind of the times. It is beginning to be found that the history of geology provides a rich field, hitherto relatively unexplored compared with the histories of the other sciences; and the importance of this book is apparent when it is realized that it seems to be the first massive combined and concentrated achievement in geological historiography. The publication of Darwin's *Origin of Species* in 1859 is taken, perhaps rather surprisingly but not unreasonably, as the culmination in the development of a rational view of the Earth, and the studies here presented provide, with their penetrating scholarship, a deep insight, at the selected points, into the growth of geology up to that time. Geology is a craft, an ever increasing body of knowledge, and a continual search for a true interpretation of the facts (origin, process, time); but, because it is above all a science, it cannot neglect its history.

Specialists from several countries write on geologists and subjects from Russia, Germany, Italy, France, Great Britain and the United States. This can be illustrated by mentioning a few representative papers. After an introduction by the editor, Professor Cecil J. Schneer of the University of New Hampshire, the first paper is by Franck Bourdier (France) on "Geoffroy Saint-Hillaire versus Cuvier: the Campaign for Paleontological Evolution", and he claims that Geoffroy ranks with Lamarck as a precursor of Darwin. John G. Burke (USA) discusses mineral classification in the early nineteenth century. Albert Carozzi (Switzerland and USA) expounds the theory of the Earth put forward by de Maillet in his *Telliamed* (1748), a work he has recently translated and annotated. R. H. Dott (USA) considers Huttonian theory in its aspect of providing "a dynamic evolutionary earth view". Both Dott and V. V. Tikhomirov (USSR), in his "Development of the Geological Sciences in the USSR from Ancient Times to the Middle of the Nineteenth Century", bring especially to notice M. V. Lomonosov (1711–1765) as a precursor of Hutton's ideas. V. A. Eyles (UK) gives an illuminating account in his paper on "The Extent of Geological Knowledge in the Eighteenth Century, and the Methods by which it was Diffused". Amongst the other titles are the following: Leroy E. Page (USA), "Diluvialism and its Critics in Great Britain in the Early Nineteenth Century"; Martin J. S. Rudwick (UK), "Lyell on Etna, and the Antiquity of the Earth"; and George WhW. ite (USA), "Early Geological Observations in the American Midwest". The great names of James Hutton, A. G. Werner, William Smith and Charles Lyell are prominent in these essays, as they always must be in any treatment of that richest half-century of geological progress, 1790 to 1840. Discussion of their philosophy, achievement, and influence seems inexhaustible, and we await with great expectations the books that are promised on Smith and Lyell by Joan M. Eyles and Leonard G. Wilson respectively (both are contributors to this volume).

The articles are substantiated and enriched with copious documentation, and there is a full index. As often happens with works of scholarship, the illustrations, as a whole, hardly do justice to the text; some are not particularly appropriate, while many are poorly reproduced. Finally, the price is decidedly high, even for 469 pages of writing of the highest quality. JOHN CHALLINOR