here by Flannery will provide some of the key data and interpretation bearing on this major anthropological problem.

Several papers are concerned with regional settlement surveys of ancient complex societies. Two of the best are by J. Ward-Perkins for central Italy north of Rome, and R. Adams for southern Mesopotamia. Both authors have only limited control over functional variability within or between their sites, and thus they cannot yet adequately describe the successive settlement systems they are dealing with. They can, however, delineate changing regional settlement patterns over broad areas throughout a very considerable time period, and thus make some very sound inferences concerning a variety of cultural processes. Ward-Perkins's study has the additional advantage of having good historic documentation for much of the time period of interest, and his findings may have some applicability to wholly prehistoric situations elsewhere: he finds that major changes in settlement pattern occur in the context of either the construction of new communication-transportation arteries or a massive breakdown in effective governmental authority.

A final theme of great interest is an explicit effort to define the state and process of urbanism. This is a problem that has plagued archeologists for decades. There have been several attempts to provide definitions of urbanism that are useful in a prehistoric context—but these have often proved both imprecise and productive of sterile argument. This problem stems in part from a common failure among prehistorians to consider some of the theoretical bases for distinguishing "urban" from "rural" in different kinds of societies. Papers by M. Smith, D. Grove, and B. Trigger all emphasize the inadequacy of the size and density variables generally employed by archeologists to differentiate urban from nonurban communities: there is simply too much overlap for these to be readily useful. These writers, and others, stress that functional considerations are the key variables—as many archeologists have long recognized. Furthermore, the point is well made that urbanism probably cannot be defined on an absolute basis, cross-culturally, but must be considered in a relative sense for each system under consideration. These are all critical points. The main problem, however, is not directly attacked here: how are we to apply these considerations to prehistoric archeological data?

Two general criticisms of the volume come to mind in conclusion: (i) there is an inadequate treatment of the recent highly relevant advances in the methodology of functional inference; and (ii) there is too limited useful application of many stimulating theoretical issues to bodies of archeological data. The latter deficiency is particularly significant, and it may well indicate that many of the archeological data we now possess are inadequate for the kinds of questions we now wish to ask about process in prehistory.

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Philosophical Idea

Hierarchy Theory. The Challenge of Complex Systems. HOWARD H. PATTEE, Ed. Braziller, New York, 1973. xvi, 156 pp., illus. Cloth, $6.95; paper, $2.95. International Library of Systems Theory and Philosophy.

This is a book of six essays on the general subject of hierarchies in the natural world. The point of the whole book is to convince the reader that it is important to analyze natural systems as hierarchies; consideration at one level alone is bound to have severe limitations. It would seem to be something we all knew: has the book made either the need or the process any clearer? The advantages gained, I fear, are very slight despite some excellent essays and some original ideas. The good essays are descriptions of particular hierarchial systems. The two on development in living organisms by Clifford Grobstein and James Bonner are to be recommended. Among the good ideas special note should be made of Herbert Simon's temporal model for the evolution of hierarchial levels. He shows that the grouping of events in time produces stability points that do not disintegrate and that provide stepping-stones for future change. Another important idea is that of Richard Levins, who points out that through natural selection a complex system is bound to evolve into a system of interconnected subunits or hierarchies; hierarchial levels do not all arise by the compounding of simpler ones; they also may arise by the subdivision of a complex system.

The book raises two important points, both of which are found in the larger contributions of the editor, Howard Pattee. First, whereas most of the authors, like Levins, assume that natural selection plays a major role in the formation of biological hierarchies, Pattee adopts the mathematician-physicist position that not only is Darwinian theory basically suspect but there must be a more fundamental "hierarchy theory" that applies equally to physical as well as biological hierarchies. Second, the assumption is made that there is a "hierarchy theory" to be discovered and that once established it will shed an enormous amount of light on all of nature. I find myself quite skeptical on this point. It seems to me that it is essentially a philosophical point, and that in the past the track record for the illumination of science by philosophy has been poor. On the most esoteric level, with all its analytical power, symbolic logic did little for science other than comb out some of the nonsense. A better example might be the earlier interest in emergent evolution and holism, which were to be theoretical frames that would provide greater insight into the nature of biological complexity. To a very limited degree they were helpful as a way of organizing thoughts, and the same can be said of looking at living and nonliving systems as hierarchies (or as objects of "systems analysis"). But, in my view, the advantage gained by such "hierarchy theory" is, and will remain, modest, and hierarchy theory is not, in itself, likely to be the avenue of large, exciting advances in either physics or biology.

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Antarctica

Antarctic Geology and Geophysics. Proceedings of a symposium, Oslo, Norway, August 1970. RAYMOND J. ADIE, Ed. Universitetsforlaget, Oslo, 1972. x, 876 pp., illus. $65. International Union of Geological Sciences, Series B, No. 1.

This comprehensive volume on Antarctic geology and geophysics contains 126 papers (seven in abstract form only) which were presented at a symposium organized by the Scientific Committee on Antarctic Research (SCAR). It is probably the most complete and up-to-date work on the structure of the Antarctic continent and surrounding areas now in print. There

are sections for six different geographic areas, illustrated by many excellent photographs, and a shorter seventh section on Antarctica and continental drift.

The first section, on the Scotia Arc and Antarctic Peninsula, contains a review paper emphasizing the considerable effort that the University of Birmingham has devoted to studying the structure beneath the Scotia Sea and relating it to adjacent land. Magnetic lineations indicating a center of sea floor spreading in the eastern Scotia Sea are reported. A second review paper, and other papers, illustrate the recent advances in the geology and geophysics of the Antarctic Peninsula and suggest similarities to the Andean structure of southern South America. There are seven papers from Chile on the South Shetland Islands.

The second section is on western Antarctica, which includes Marie Byrd Land, bordering the South Pacific Ocean, and Ellsworth Land, south of the Antarctic Peninsula. Two distinct orogens are recognized—one in each of these two regions. Active volcanoes are still found in Marie Byrd Land. The United States has long been active in this part of the southern continent and contributed ten papers on this region. Here also Chile's interest is reflected, in four contributions.

The Transantarctic Mountains divide western from eastern Antarctica, the eastern part being the larger and containing the south geographic pole. These mountains pass just south and west of the Ross Sea and constitute much of Victoria Land, which forms the western margin of the Ross Sea. Because of McMurdo base nearby U.S. scientists have studied localities in Victoria Land extensively. That area fits against southeast Australia in continental reconstructions. Fifteen contributions are presented on this region by the U.S. scientists. These include one by E. H. Colbert, who presents a review on Antarctic tetrapods, especially the Triassic land-dwelling reptile *Lystrosaurus*, the fossil distribution of which in the Southern Hemisphere suggests continental drift.

The largest section of the book is devoted to the eastern Antarctic. Much of this area is unknown because of ice cover, which approaches 3 kilometers in places. Rock exposures near the coast of the South Indian and southeastern Atlantic oceans have led to a concentration of geologic studies there. The Soviets have been by far the most active in this sector. There are, however, contributions from ten countries, including important ones from the Republic of South Africa. For the interior of the continent a few radio-echo soundings beneath the ice cover are reported. These show, among other important topographic features, the buried Gamburtsev Mountains. Seismic refraction profiles have been made across the eastern part of the continent. In places they show lower crustal velocities as shallow as 4 kilometers below sea level. The United States has shown relatively little scientific interest in the area. Eight review articles, four by Russian scientists, offer a good opportunity to compare theories of the geology of this massive area.

A short section on the Southern Ocean, here meaning the far South Pacific Ocean, reports results from the ship *Eltanin*, which was operated by the National Science Foundation. Most of the marine geophysical results have been reported elsewhere. They provide strong support for the theory of sea floor spreading. Other papers report on deep sea sediment studies. Unfortunately the *Eltanin* has recently been taken out of service, and the far South Indian and Atlantic oceans will not receive the study which has been devoted to the Pacific sector of the Southern Ocean.

Intensive geological studies on the sub-Antarctic Islands of the Atlantic and Indian oceans have been undertaken by geologists of the University of Paris. Here they report on the petrology and geochemistry of a dozen islands extending from Macquarie Island south of New Zealand to Tristan da Cunha in the South Atlantic.

The concluding section on continental drift contains little new information but is of value since it reviews existing theories with emphasis on the special role of the Antarctic continent in these theories.

To echo one of the authors, "Although its scientific exploration began less than 80 years ago, Antarctica is destined to play a fundamental part in establishing the geological history of the Southern Hemisphere." The intense international effort on the southern continent as well as the recent results of the *Glomar Challenger* drilling program in Antarctic waters is showing the truth of that statement.

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The Leaf

Analysis of Leaf Development. ROMAN MAKSYMOWYCH. Cambridge University Press, New York, 1973. xiv, 110 pp., illus. $12.50. Developmental and Cell Biology Series.

Most human metabolic activity is sustained by the activity of leaves. In fact, the energy transductions carried out by leaves support the bulk of terrestrial life. By any engineering standard, a photosynthesizing leaf is a marvel of efficiency. It is no wonder that photosynthesis and other processes carried out by the leaf have engaged the attention of numerous investigators. What is surprising is that, since the appearance of Avery's classical paper on tobacco leaf development in 1933, relatively little research has been carried out with intact leaves following an undisturbed course of development.

The splendid little book by Roman Maksymowych, the result of over ten years of research, deals with the day-to-day activity of leaf development. The book begins with a description and discussion of the leaf plastochron index (LPI), a quantitative indicator of leaf development, then proceeds to describe both the morphological and the accompanying physiological changes in terms of the LPI. It is puzzling that the leaf has not elicited more attention from developmental biologists: In dicotyledonous plants leaf morphogenesis follows a pattern much more characteristic of animal than of plant growth. The leaf attains a fixed size and has a finite life span. Its development is tightly programmed: cell division, enlargement, differentiation, functioning, and finally senescence. The descriptions should be helpful not only to developmental biologists but also to any investigators whose research involves leaves, such as physiologists working on photosynthesis, photoperiodism, or other effects of light, or horticulturists applying chemical sprays to leaves—the book will help such workers understand better the material they are working with. In addition, considering the fact that leaf development provides a model, and that leaves during various stages of development synthesize a variety of esoteric compounds from hormones to complex phenolics, other scientists would profit by glancing through this book. This reviewer was enlightened by the brief chapter on respiration, which describes the increase in oxygen consumption with cell maturation, a phenomenon of interest to those devel-