cluding Harper. The other papers on ecophysiology, which deal with the responses of plants to light, water, defoliation, and mineral nutrients, are matter-of-fact reviews without many critical, stimulating ideas, and they conclude generally with pleas for field studies. This is an interesting irony, since most field workers in population biology are asked to look into the causal processes underlying their observations by designing precise, controlled laboratory studies. This symposium makes the point that both approaches are needed.

In his summative address de Wit is, as usual, witty and humorous, but he does not attempt a grand synthesis. On the other hand, Baker and Tothill provide excellent reviews of the origin, geographical distribution, broad evolutionary features, and current work aimed at the improvement of pasture species. Several research topics emerge from their surveys: growth habit of perennials versus annuals in adapting to grazing, the role of breeding systems, the population structure of early and late successional species, establishment by seed, species diversity versus intraspecific variation, and rational guidelines for the selection of pasture legumes and grasses for different tropical and temperate grasslands.

The preface includes a comment that "a book of this kind offers the reader a rare opportunity to generalize from the current state of knowledge about a subject." In fact, most population biology writings already have too many generalizations, stated as working hypotheses, firm conclusions, or something in between, depending on the author's taste and circumstance. This volume, too, has its share of cliches about community stability, *r* and *K* strategies, the Gause principle of coexistence, coadaptation, and the genetic structure of inbreeders, but its strength lies in the good reviews it provides of many aspects of pasture (range, grassland) management. Most readers will enjoy and benefit from it through updating their knowledge of work outside their own narrow specialties. It welcomes physiologists and population biologists to an applied field and does it well.

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The History of the Earth's Environment

Evolution of the Atmosphere. JAMES C. G. WALKER. Macmillan, New York, and Collier Macmillan, London, 1977. xiv, 318 pp., illus. $16.95.

A few years ago the need for solutions to environmental problems began to put pressure on various kinds of scientists to pool their resources. Meteorologists, oceanographers, biologists, geochemists, and hydrologists found themselves team-teaching to train students properly. From such associations the scientists began to realize that there is indeed strength in union. Atmospheric scientists were trying to understand the reasons planetary atmospheres have the compositions they do and began to look into the geologic evolution of the planets. They consulted geochemists, who, in turn, realized that the atmospheric scientists could help them. *Evolution of the Atmosphere* is, as far as I know, the first attempt to bring together the products of such scientific weddings. In it J. C. G. Walker admirably melds atmospheric science and geology to give an account of the subject that will surely open a lot of eyes to the incipient power of the combined disciplines.

Is our atmosphere primary or secondary? Has it evolved significantly in its more than three billion years of history? What changes were initiated by the appearance of life? When and why did oxygen appear? What are the feedback systems that prevent great oscillations of atmospheric composition? These are some of the geologic questions raised by Walker and discussed by him in the light of modern atmospheric chemistry and physics.

The book is organized into three parts, totaling seven chapters. Chapter 1 provides background information on the structure and chemical composition of the atmosphere, with, for example, derivations of equations for lapse rate and diffusion time. The chapter includes discussions of the chemistry and structure of the oceans and the crust and a short section on biology and the geologic time scale.

The next three chapters describe the processes that control the composition of the present-day atmosphere—photochemical processes, processes at the bottom of the atmosphere, and processes at the top of the atmosphere. These chapters include rather detailed photochemistry, derivation of equations for escape velocities, and discussion of the interactions of gases with earth materials.

The final three chapters treat the early evolution of the atmosphere—the origin of the atmosphere, its properties prior to the development of life, and its evolution thereafter. Where appropriate, the discussion includes Venus and Mars.

The chapters are uneven in technical level. Chapter 4, "Loss of atmospheric gases to space," is 35 pages largely devoted to the derivation of equations, whereas the three chapters on the ancient atmosphere are largely expository and speculative. This unevenness is an expression of the current state of knowledge. For the reader interested in the cycles of elements or the rise of oxygen, Walker provides the quantitative tools of the modern meteorologist. For the meteorologist, he displays the range of problems that must be solved before the history of life and of the surface environment of the earth can be known even qualitatively. Furthermore, he shows the important role played by atmosphere-earth and atmosphere-ocean interactions in controlling the composition of the atmosphere.

Walker has made a well-balanced presentation of a still poorly defined field. There are many individual items, however, that invite comment. For example, he dismisses climatic effects of CO_2 increase in the atmosphere as unimportant. His stand is interesting in light of the current furor concerning these effects. Also, he concludes that the rate of uptake of CO_2 by chemical weathering of rocks is directly related to the CO_2 pressure of the atmosphere, an idea that became suspect some years ago when it was pointed out that the weathering of rocks is largely controlled by the CO_2 content of the soil atmosphere, which in turn is controlled by the rate of oxidation of soil humus.

Walker uses the "we" style extensively; for example, "We adopt the homogeneous accretion model." Occasionally "we" do not necessarily wish to accept or adopt or describe or assume what Walker does.

Although he carefully gives references and credits others when his discussion draws on their work, I got the impression that I had been invited into Walker's world. In other words, although the book is fully referenced, it is not a review but largely a documented exposition of Walker's views. He has managed to give a good feeling for the lack of constraints on many of the systems he has chosen to

discuss. Occasionally, however, I wished he had discussed the alternatives he eliminates as unlikely; he does not treat the evolution of an atmosphere on a cooling earth surface, for example, although that possibility has attracted a number of other workers.

One of the most valuable parts of the book is a bibliography of more than 500 items. I cannot vouch for the meteorology, but the coverage of the pertinent geological literature is excellent. The book shows little concern with historical development of ideas; more than 90 percent of the references are post-1960. There are references as recent as 1977, but full coverage essentially ceases at the end of 1973.

I find it a little odd that Walker has not made and "operated" quantitative models; his numerical discussions of feedbacks in various systems make it clear that he has come to the verge of mathematical modeling of entire systems. Walker has done a great service in providing a book that expresses current knowledge of the subject well and one that surely heralds the development of quantitative modeling.

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Cancer Biology

Cancer Invasion and Metastasis. Biologic Mechanisms and Therapy. Papers from a workshop, New York, Dec. 1976. STACEY B. DAY, W. P. LAIRD MYERS, PHILIP STANSLY, SILVIO GARATTINI, and MARTIN G. LEWIS, Eds. Raven, New York, 1977. xxii, 518 pp., illus. $35. Progress in Cancer Research and Therapy, vol. 5.

The tumor that may kill differs from the lump that is merely inconvenient or unsightly in one of two ways. Trouble is at hand when the tumor mass breaks through nearby basement membrane or when bits of it get into the circulation, successfully seed a distant tissue, and begin their own autonomous growth. The first trouble is called invasion, the second metastasis. Tumors that can do one or the other are fittingly called "malignant": they are bad news.

The baseline for studying either invasion or metastasis is an animal bearing, or about to grow, a malignant tumor. Such animals do not provide the easiest or the best-defined systems for biochemical or genetic analysis of either malignant process. But we try our best. This book, the record of a meeting at the Sloan-Kettering Hospital, summarizes work on the subject quite well. In most cases the news is not good. Because scientists studying metastasis are dealing with a second-order (albeit lethal) event, they have no normal controls, only differences among already cancerous cell populations. Still it comes as a surprise to learn from these clinical and whole-animal studies that among the agents that increase metastasis in an animal (or a person) with a bad tumor are x-rays at the primary tumor site, glucocorticoids, and general anesthetics. That is, because of our ignorance of basic mechanisms, the triumvirate of therapies we use for the initial tumor (radiotherapy, chemotherapy, and surgery) may well be sowing iatrogenic metastases. Clearly, basic mechanisms must be intensively studied if we are ever to follow Hippocrates and "do no harm" while treating cancer.

This book contains almost three dozen laboratory review articles on the specific mechanisms and current therapies of malignancy. Metastasis seems to be a hotter subject than invasion. To a cell biologist the papers on the mechanisms of metastasis make much more interesting reading than the ones on its therapy. Certainly they are less depressing. Cell characteristics claimed to have predictive value in determining high metastatic potential include adhesion (Nicolson), aggregability (Poste), clumping (Good), platelet aggregation (Warren, Chauvin, and Philips), inability to be recognized by macrophages (Alexander), production of inappropriate surface antigen (Levine), release of angiogenic capillary-proliferative factors (Folkman and Tyler), and production of proteases (Kleinerman and Liotta) and protease activators (Weinstein). Last but not least, the exhaustive studies of Fidler, Gersten, and Riggs show that specific metastatic ability may be inherited by the tumor cells and that its biochemistry may therefore be studied in matched pairs of clones differing only in metastatic efficiency or target specificity.

These markers are not so exotic as one might have thought. Indeed, they read like a short list of key words in a National Cancer Institute research grant application. Why then are so few laboratories applying to metastasis the incisive biochemistry now lavished on the tumor viruses? Perhaps this book will help a few smart people get up the nerve to get their gels a bit dirty. One quibble: the book lacks an author index.

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Books Received

Annual Review of Entomology. Vol. 23. Thomas E. Mittler, Carroll N. Smith, and Vincent H. Resh, Eds. Annual Reviews, Palo Alto, Calif., 1978. xii, 524 pp., illus. $17.

Annual Review of Fluid Mechanics. Vol. 10. Milton van Dyke, J. V. Wehausen, and John L. Lumley, Eds. Annual Reviews, Palo Alto, Calif., 1978. xii, 476 pp., illus. $17.

Appropriate Technology. Problems and Promises. Nicolas Jéquier, Ed. Organisation for Economic Co-operation and Development, Paris, 1976 (U.S. distributor, OECD Publications Center, Washington, D.C.). 346 pp. Paper, $12.50. Development Centre Studies.

Atherosclerosis. Metabolic, Morphologic, and Clinical Aspects. Proceedings of a conference, London, Ontario, Canada, Sept. 1975. George W. Manning and M. Daria Haust, Eds. Plenum, New York, 1977. xxxviii, 1018 pp., illus. $75. Advances in Experimental Medicine and Biology, vol. 82.

Biology of Developing Systems. Philip Grant. Holt, Rinehart and Winston, New York, 1977. xvi, 720 pp., illus. $18.95.

British Electro-optics. Proceedings of a conference, Tokyo, Dec. 1975. L. R. Baker, Ed. Taylor and Francis, London, 1977 (U.S. distributor, Crane, Russak, New York). viii, 142 pp., illus. $21.50

Cancer Metastasis. Approaches to the Mechanism, Prevention, and Treatment. Papers from a conference, Kona, Hawaii, May 1976. Philip G. Stansly and Haruo Sato, Eds. University Park Press, Baltimore, 1977. viii, 248 pp., illus. $44.50.

Carotenoproteins in Animal Coloration. Welton L. Lee, Ed. Dowden, Hutchinson and Ross, Stroudsburg, Pa., 1977 (distributor, Academic Press, New York). xvi, 396 pp., illus. $30. Benchmark Papers in Biological Concepts, vol. 3.

Cauldron of Hell: Tunguska. Jack Stoneley. A. T. Lawton, Scientific Editor. Simon and Schuster, New York, 1977. 216 pp. + plates. $8.95.

Chemical Analysis of Organometallic Compounds. Vol. 5, Elements of Groups VIA, VIB, VIIA, VIIB, Aluminium and Zinc. T. R. Crompton. Academic Press, New York, 1977. xii, 432 pp., illus. $46.90. The Analysis of Organic Materials, 4.

Introduction to Group Theory with Applications. Gerald Burns. Academic Press, New York, 1977. xvi, 430 pp., illus. $18.50. Materials Science and Technology.

Introductory Statistics. Roger E. Kirk. Brooks/Cole, Monterey, Calif., 1978. x, 438 pp., illus. $14.95.

Inversion Methods in Atmospheric Remote Sounding. Proceedings of a workshop, Williamsburg, Va., Dec. 1976. Adarsh Deepak, Ed. Academic Press, New York, 1977. xvi, 622 pp., illus. $28.

Kinship and Marriage in Burma. A Cultural and Psychodynamic Analysis. Melford E. Spiro. University of California Press, Berkeley, 1977. xx, 314 pp. $15.

Let's Learn about Aging. A Book of Readings. John R. Barry and C. Ray Wingrove, Eds. Schenkman, Cambridge, Mass., and Halsted (Wiley), New York, 1977. xvi, 528 pp., illus. $18.50.

Lightning. R. H. Golde, Ed. Academic Press, New York, 1977. Two volumes. Vol. 1, Physics of Lightning. xx, 496 pp., illus. + index. $41. Vol. 2, Lightning Protection. xx + pp. 497–850, illus. + index. $33.25.

(Continued on page 284)