ously clear. A reader with little scientific or engineering background should have no difficulty in understanding the text, supported as it is with numerous well-chosen illustrations. Obviously the writers have had long experience in elucidating complex technical questions.

These very real virtues are, however, achieved at considerable cost. The clear, technically precise, and authoritative accounts produce an abstract, bloodless, and largely anonymous history; the scientists and engineers responsible for some very remarkable achievements are little more than names attached to ideas or artifacts. The general impression conveyed is one of inevitable technological progress with few evidences of misdirected efforts, scientific failures, or technical frustrations. Readers interested in the processes of scientific creativity or technological innovation will be disappointed in these pages.

This volume also demonstrates some paradoxical attitudes toward institutions. On the one hand readers interested in problems of research administration will find little of interest. There is a discussion of the various organizational changes that resulted in the creation of Bell Telephone Laboratories in 1925, and there is conventional praise of collaborative research. But we learn little or nothing about such critical matters as personnel recruitment, decision-making on research and development projects, and changing levels of support. On the other hand the volume demonstrates a degree of institutional myopia. To be sure, due credit is given to innovators outside the Bell System, but their role seems extraordinarily small. For example, the volume pays close attention to H. D. Arnold's crucial role in developing the modern vacuum tube, but there is little attention given to the work of others and no mention at all of the resulting tangled patent situation shortly after World War I that led to AT&T involvement in the formation of RCA.

The authors do develop one important institutional thesis. They characterize the close integration of operations, engineering, and manufacture as a "wise and productive move" (p. 1008). At a time when the federal government seeks to force AT&T to divest itself of Western Electric this is a most important point. The argument is often persuasive, but it would have been more persuasive coming from independent scholars writing with free access to Bell materials. The matter of materials presents one final disappointment. The bibliography and scattered footnotes refer almost exclusively to published materials. There are some references to internal documents, but we are left with no clear indication of the richness (or poverty) of Bell archives for students of the history of American technology and industrial research.

This is obviously an important work. No one interested in the development of communications technology can afford to overlook it. It has provided clear and authoritative answers to some important questions. But the authors' range of interest was narrow. The Bell System could make a further contribution to the history of American technology if it would permit qualified scholars to use its archives to seek answers to some of the questions the authors of this volume chose not to ask.

KENDALL BIRR
*History Department,*
*State University of New York, Albany*

## Biochemical Method

**Protein Crystallography**. T. L. BLUNDELL and L. N. JOHNSON. Academic Press, New York, 1976. xvi, 568 pp., illus. $43. Molecular Biology.

*Protein Crystallography* will be welcomed by crystallographers, but, more important, I believe it will be readily comprehensible to protein chemists and enzymologists, with whom protein crystallographers enjoy important and fruitful collaborations.

The book is unique in that it gathers together in a highly readable form most of the important methodologies of protein crystallography, especially those which distinguish it from its older sibling, small molecule crystallography. Other crystallography textbooks have presented in considerable detail the material on symmetry, space groups, and principles of x-ray diffraction that is covered in two chapters of this book. Such textbooks have tended to gloss over the special features of proteins that lead to unique experimental problems—for example, the crystallization of proteins, the collection and processing of multiple large data sets, and the preparation of heavy atom derivatives. Knowledge of these and other specialized techniques had to be gleaned from journal articles, reviews, and attendance at the numerous protein workshops and by apprenticing oneself to a proven leader in the field. Now, for the first time, we have a comprehensive protein crystallography textbook, complete with a few hundred references, practical hints (such as where to buy crystal mounting tools), warnings (don't ingest heavy atoms), illustrations (some of which reflect the authors' own research experiences), and an adequate theoretical background. The book can be used by a beginning student to learn the field and by an experienced protein crystallographer as a handy reference guide.

What about the noncrystallographer? A few chapters of the book can be read by those interested in a better perspective of the study of protein structure. The principles of protein structure are discussed, and summaries of the techniques used in x-ray and neutron diffraction and in electron microscopy are given. There are referenced tables of the enzymes studied by x-ray diffraction and a discussion of some of the results. In addition, the chapter on crystallization and the chapter on heavy atom preparation, with its extensive tables of binding sites, should provide invaluable information for protein chemists and enzymologists. Finally, it is a credit to the authors that the chapters on crystallographic techniques are written in such a way that someone outside the field could, if he or she so desired, learn more about the tool that has become so crucial to our understanding of molecular structure and function.

HELEN M. BERMAN
*Institute for Cancer Research,*
*Philadelphia, Pennsylvania*

## Hard-Working Intact Muscles

**Biomechanics and Energetics of Muscular Exercise**. RODOLFO MARGARIA. Clarendon (Oxford University Press), New York, 1976. x, 146 pp., illus. $15.75.

Despite its misleadingly comprehensive title, but as is made clear in the preface, the contents and style of this small book are very personal and relate mainly to the researches that Margaria (and his colleagues) have carried out in the last ten years in the Institute of Human Physiology of the Medical School of the University of Milan. Thus, although the book is intended to cover the fundamentals of the physiology of exercise, it has many large gaps. There is no mention, for example, of myosin and actin, of enzymes, of controls at the cellular level, of adenosine monophosphate (AMP) or cyclic AMP, of the significance of changes in the respiratory quotient for the energy available from a given amount of oxygen, or even of fat metabolism, without doubt by far the largest source of energy for low-level muscular exercise.

These gaps make it impossible to rec-

ommend the book as an account of the fundamentals of even the physiology, never mind the biochemistry, of the energetics of muscular exercise. However, as a fine account of what has "awakened the passion and interest" of Margaria, it is well worth reading.

Most of the book is based on simple measurements on human beings exercising at relatively high rates. A clear account is given of the major types of oxygen debt, of changes with exercise of cardiorespiratory function at sea level and at high altitudes, and of the "biomechanics of human locomotion." The problems of walking, running, and jumping on the earth's surface are presented and contrasted with the situation on the moon.

Perhaps the most important part of the book is a description of how, with a good stopwatch, some stairs, a chair, and the nomograms printed here, sufficiently accurate measurements can be made to estimate a person's maximum aerobic and anaerobic powers. Without doubt these powers should be much more widely known, not only to athletes, coaches, physiotherapists, and physicians, but to anyone who wants to monitor something closely related to physical fitness as it changes with the years.

It is refreshing to see an (albeit touched-up) series of photographs of what seems to be a woman sprinter on the book cover, but depressingly typical to see it described in figure 3.12 as "stroboscopic image of a running man."

R. E. DAVIES
*Department of Animal Biology, School of Veterinary Medicine, University of Pennsylvania, Philadelphia*

## Basic Ideas in Ecology

**Theoretical Ecology**. Principles and Applications. ROBERT M. MAY, Ed. Saunders, Philadelphia, 1976. viii, 318 pp., illus. $13.50.

This book is intended to introduce simple ecological models and their applications to undergraduates and others who have had approximately one year of calculus. It succeeds well in this aim. The contributors—May, T. R. E. Southwood, M. P. Hassell, G. Gaughley, E. R. Pianka, J. M. Diamond, H. S. Horn, E. O. Wilson, S. J. Gould, J. E. Cohen, and G. Conway—are a distinguished group of ecologists whose specialties include theory, fieldwork, and applications. Often the writing style is uncommonly good, and the spirit of modern ecological research is clearly and enthusiastically conveyed.

The book begins with two chapters on models for the population dynamics of single species, then offers three more chapters on models for two interacting populations, then four chapters on community-level phenomena, and finally a set of four chapters on the applications of theoretical ecology to allied fields. These concluding chapters discuss sociobiology, paleobiology, epidemiology, and pest control. The book is well balanced in its coverage of theoretical and empirical topics. Also, it is unusual in providing equal time to various predator-prey models and to competition models. I would like to point to several chapters that present material that is difficult to obtain from other sources. Hassell presents a useful synthesis of predator-prey models specially applicable to arthropods, Pianka pulls together a huge literature on niche theory and related field observations, May reviews empirical phenomena at the community level, Cohen summarizes the population dynamics of schistosomiasis parasites, and Conway presents an account of the biology of pest control.

The book is somewhat mistitled; it is an introduction to theoretical population ecology and not to the whole field of ecology. There are no chapters on the theory relating to the ecology of individuals, for example on models of foraging strategies, optimum leaf design, or daily activity cycles as a function of temperature. Nor are there chapters on ecosystem modeling. These remarks are not intended as a criticism, for the book is sufficiently long as it is and is well integrated. I predict that it will be well received and plan to use it myself in courses.

My principal reservation about the book has to do with its lack of chapters on evolutionary ecology and, more generally, an unfamiliarity with the relevant theory of evolutionary ecology on the part of many of the contributors. Consider three specific circumstances that illustrate this difficulty. First, the distinction between $r$- and $K$-selection is central to some of the chapters and is mentioned in most of the others. In recent years a lore has been fabricated concerning the life history traits that are supposed to evolve under $K$-selection as distinct from $r$-selection. The concept of $K$-selection and its extensions are well defined only in the context of density-dependent selection; to have a carrying capacity means there is some form of density dependence. Yet the actual theory of density-dependent selection is based on the standard discrete-generation model of population genetics and simply does not address the relationship of life history characteristics to density-dependent selection because the models do not involve age-structured populations. On the other hand, the theory to date dealing with selection as it affects age-structured populations does not involve density dependence—it adds genetics to the standard density-independent model of demography. This theory does appear to be able to account for the observed correlations between life history traits and environmental disturbance—all without reference to density dependence and perforce $K$-selection. The lore of $r$- and $K$-selection is a separate matter from the actual theory on this topic and it stands or falls independently. In this regard the third chapter, on "bionomic strategies," should be read with particular caution.

A second illustration of the neglect of evolutionary ecology is to be found in the discussion of mutualism in the fourth chapter. It is known empirically that there are more mutualistic associations in the tropics than in comparable temperate habitats. The suggested explanation is that mutualistic interactions lead to a weakly stable equilibrium point for the coexisting species. Hence, it is suggested, such associations do not persist in strongly fluctuating environments. But it has been demonstrated that the condition for the evolution of a mutualistic strategy cannot be easily satisfied if the potential host species in the association has a high turnover. From evolutionary considerations there should not be any mutualistic associations in temperate or highly fluctuating habitats; and, if there is not, the issue of ecological stability can rarely if ever arise. Thus an evolutionary explanation appears to preempt one based on population dynamics alone. Incidentally, most ecologists are unaware of the important theoretical work on symbiosis, including mutualism, by Kostitzen in the 1930's.

A third illustration is the pointed remark by Graeme Caughley in concluding his chapter on plant-herbivore systems. He writes that he awaits the time when population geneticists "grow weary of their pivotal assumption that a population has no dynamics" and when population dynamicists "abandon the belief that a population has no genetics." One need wait no longer; there already is a rich and growing literature that has answered this challenge.

JONATHAN ROUGHGARDEN
*Department of Biological Sciences, Stanford University, Stanford, California*