

may be a timely one, consisting as it does of a justification of the activities of the Atomic Energy Commission in supporting research on and development of peaceful uses of atomic energy. For in spite of its all-encompassing title, that is precisely what the book is.

It is somewhat difficult to decide which segment of the population the authors were trying to address, for it cannot be said that this book will appeal to the general public. In spite of valiant attempts to explain such difficult concepts as half-life and, indeed, radioactivity itself, the book is replete with charts and diagrams which it is doubtful a layman not already versed in mechanical concepts would be able to understand. And on the other hand, these explanations might appear superfluous to those who can comprehend the details of the working principles of, for example, a breeder reactor.

The book contains adequate descriptions of the nuclear power program of the Atomic Energy Commission, the Plowshare program (the use of nuclear explosions for earth moving and canal building), the usefulness of radioisotopes in agriculture and biology and medicine, and many ambitious and highly imaginative projects in space travel and planetary engineering, some of them verging on science fiction. However, one emerges from reading the book with a distinct feeling of uneasiness. Each chapter reassures us of the inherent safety of the development described and explains the enormous care which is undoubtedly taken to protect the public. And it would be hard to find fault with any of these precautions. Yet one cannot help feeling that if all the things that are described in this book come to pass, then our lives and our health will depend upon three factors: the ability of the medical profession to make a quantitative assessment of the hazards of radiation exposure, the ability of engineers to provide the necessary precautionary engineering, and finally overcoming the much more difficult problem of maintaining administrative controls that are not subject to the whims of international politics or capricious domestic exigencies. Should any of these three lines of defense fail, then the entire population of the world could be in serious danger. While the authors may be able to reassure us about the knowledge available in the field of medicine and the skills available in the field of

engineering, it is not within their capacity or intent to reassure us about the stability and wisdom of administrative decisions by our government or anyone else's.

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Mechanisms of Behavior

Neal E. Miller: *Selected Papers*. Aldine, Chicago, 1971. xiv, 874 pp., illus. \$15.

Neal Miller is one of a very few who have made truly significant contributions to the elucidation of the mechanisms that control behavior. Thus this collection of his writings will be of great interest not only to professional workers in experimental, physiological, and clinical psychology but to those in other disciplines who are particularly interested in behavior. A number of facets of his extraordinarily diverse research career emerge from the selected papers.

First, there is Miller as Innovator. To take a limited sample, there are crucial findings concerning approach and avoidance behavior in animals, trenchant comment and experimentation on the physiological processes involved in memory, ideas about the relevance of information theory in studying the nature of reward, and most recently the demonstration that visceral "involuntary" responses can be brought under the control of "voluntary" reward mechanisms.

These in turn lead to a second facet of his work, that of Miller as Generalizer. This appears, for example, in the pervasive effort to bring laboratory, infrahuman data to bear on clinical phenomena that range from the psychopathologic to the cardiovascular, and again in a pioneering, integrated approach to drug action from which we learn not only something about selected drugs but also how such an analysis can be brought to bear on basic psychological phenomena.

The latter example brings up the most important theme implicit in this collection, the role of Miller as Integrator that is inherent in his research style. This style is one in which ideas and concepts from one domain are clarified (often no small task in itself) and brought to bear on yet another domain; that is step 1. Step 2 is a refinement of concepts in the second do-

main that typically lead to feedback to the first, as well as to an extension to yet a third domain. What emerges is a research style that is truly, not merely nominally, interdisciplinary.

This rare research style emerges, however, only for the relatively sophisticated reader, because by and large the papers or clusters of papers stand in isolation without adequate integration into the several mainstreams of behavioral inquiry of which they have been such an important part.

For instance, one of Miller's early ideas was to bring experimentally derived gradients of approach and avoidance behaviors to bear on psychoanalytic ideas about displacement. That attempt is now classic. But we now know that the determinants of the relative shapes of approach and avoidance gradients are more complex than once seemed to be the case. What bearing does this more recent complexity have on the application to displacement, and what does Miller have to say about the matter?

Again: In an early paper with Coons, Miller raises the question of whether electroconvulsive shock produces its effects by producing amnesia or punishment-induced conflict. In later papers Miller and other co-authors went on to provide important data relating to memory, on the assumption that electroconvulsive shock produces amnesia. There is no doubt that it does. But what about the punishment idea? Only the sophisticated reader will know about the transition from an important earlier concern about punishment to our present understanding of electroconvulsive shock, its utility and its limitations.

A third example relates to the recent work on the training of autonomic responses by means of operant techniques once thought to be applicable only to skeletal responses. It is now clear that, for example, the heart can be trained to decelerate by essentially the same devices that can be used to train a dog to roll over. These data have enormous implications. First, they have opened up a new vista in the treatment of diseases with autonomic symptomatology. Second, they have upended a conceptual framework that was a commonplace in psychological thinking; there was a time when sets of rules about conditioning were thought to be neatly divided in terms of the response systems to which they applied. What will the general reader

of this collection learn of these implications, both practical and theoretical? Something, but not nearly enough.

Thus the book has three kinds of shortcomings: recent, important developments are omitted; transitions between experiments are not described or are unclear; the significance of some of the work is lost because it is out of context. It could be argued that such shortcomings are inherent in the nature of collections of this kind; or that this is an important book because it reviews the work of an unquestionably important scientist. Each of these arguments has a certain validity. Yet one comes away from the collection feeling that it could have had a wider impact had some of the gaps been filled, if not by Miller then by someone else versed in the various areas in which Miller has made so many important contributions. A few papers not crucial to an adequate coverage of Miller's work could have been deleted to make room for transitional and explanatory material, and the collection could thus have been converted from one that is undoubtedly valuable to the sophisticated professional into one of far wider usefulness and importance, a book that would have been more nearly commensurate with the breadth and significance of Miller's contribution to the daily more important problem of understanding behavior.

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Approaches to Ecology

Analysis of Temperate Forest Ecosystems. A seminar-workshop, Gatlinburg, Tenn., July 1968. DAVID E. REICHLE, Ed. Springer-Verlag, New York, 1970. xii, 304 pp., illus. \$14.50. Ecological Studies, vol. 1.

This volume aims to summarize existing data on temperate forest ecosystems and to establish a conceptual framework for ecosystem analysis. It begins with an introduction to systems analysis as it applies to the study of ecosystem structure and function, moves on to consider the roles of primary producers, consumers, and decomposers, and ends with sections devoted to nutrient and hydrologic cycles.

A lucid account of systems modeling is given by F. E. Smith, using a simple

hypothetical ecosystem to illustrate the methods. D. W. Goodall points out the conceptual difficulty associated with interpreting the response of an ecosystem to variations in environmental factors when the environment itself is part of the ecosystem, emphasizing further the lack of distinction between dependent and independent variables when, as happens in ecosystems, most variables are interrelated.

The importance of recognizing and accounting for temporal variation in productivity studies is stressed by several authors. An interesting paper by H. A. I. Madgwick points to the value of canopy models in gaining an understanding of photosynthetic processes, a view reinforced by J. S. Olson in relation to carbon exchange in the biosphere. Olson's analysis of available data leads him to suggest that the contribution of terrestrial ecosystems in general, and forests in particular, to the biogeochemical cycle of carbon has previously been underestimated. A stimulating paper by G. M. Woodwell and D. B. Botkin outlines the Brookhaven approach to solving the basic production equations for terrestrial ecosystems. Based on the applications of gas exchange techniques, but still heavily dependent on harvest methods (which are discussed in greater detail by other authors), it illustrates nicely the interdependence of the several approaches to a study of ecosystem productivity.

The degree to which compensatory responses of "dependent" variables stabilize ecosystems is a contentious issue. D. R. McCullough discusses this question, defining stability as the capacity of the system to adjust to modifications. According to this view, the continuing change during community succession does not necessarily involve instability. McCullough comes down on the side of those ecologists who affirm that there is a "balance of nature," a balance which functions mainly by setting limits on deviations.

The section on decomposer populations contains a description of the use of chemical methods in estimating microbial density (L. Steubing) and a comprehensive account of the role of soil invertebrates in the decomposition of organic matter (C. A. Edwards, D. E. Reichle, and D. A. Crossley, Jr.). Lack of knowledge on the part of the reviewer concerning water flux inhibits comment on the papers which deal with this aspect of ecosystem analysis.

Because the book appears only a few

years after the English translation of Rodin and Bazilevich's comprehensive summary of production and cycling in terrestrial vegetation, the first of its stated objectives, to summarize existing data, was perhaps the more easily met. Taken overall, it achieves both this and its other aim of providing a conceptual framework for ecosystem studies, though it leaves largely to the reader the task of erecting the framework from the planks scattered among the contributions of various authors. The volume is complementary to (and in my view much more valuable than) the International Biological Programme handbook on primary production in forests.

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Evolutionary Cytogenetics

Chromosomal Evolution in Higher Plants. G. LEDYARD STEBBINS. Addison-Wesley, Reading, Mass., 1971. viii, 216 pp., illus. Cloth, \$9; paper, \$4.50. Contemporary Biology series.

After its heyday in the 1930's and 1940's, chromosome cytology suffered something of an eclipse with the burgeoning of work on microorganisms and the resulting clarification of so many aspects of the structure and function of the prokaryotic genome. Now fashion is changing again: "chromosome" and "chromatin" are becoming words of common use once more as interest moves back to the higher organism and problems connected with the eukaryotic genome and its expression in development and differentiation. As the new work gathers momentum, there is the distinct possibility that a considerable body of information bearing upon chromosome structure, behavior, and function will be lost or overlaid, necessitating rediscovery at some future date, following a pattern not unfamiliar in the history of biology. This excellent book by Stebbins therefore comes at an opportune time. Aimed at graduate-course level, it brings together in compact form a great deal of chromosome lore which will ultimately have to be integrated into any general account of the function of eukaryotic genomes, and does so in the lucid and readable style that has been a hallmark of the author's work over many years.