Yet adversity had its uses. One senses that the extraordinary thoroughness of the work embodied in *The Dance Language and Orientation of Bees* was accomplished not in spite of the difficulties but because of them. For long periods of time von Frisch was tied to his bee colonies and the simplest of equipment, and he was forced to exploit this one subject to the fullest.

Every successful scientist has a small number of personal tools with which he levers discoveries out of nature. Von Frisch had two in which he attained great mastery. The first was the repeated exploitation of the passage of honeybees from nest to flowers and back again, a complex sequence of behavioral events that is nonetheless easy to manipulate and to monitor. The second was the method of Pavlovian training, by which von Frisch associated the stimuli to be studied with a subsequent reward of food. Animals trained in this fashion will respond sharply to odd stimuli that they otherwise ignore, thus revealing ultimately their utmost sensory capacities. Using the training method, von Frisch at an early age confounded von Hess in their famous debate on color vision in insects, demonstrated the ability of fish to hear and of insects to perceive polarized light, and—over the years—sketched out in great detail the sensory *Umwelt* of the worker honeybee.

The Dance Language and Orientation of Bees is a well-written encyclopedia of the subject. It details von Frisch's methods of behavior analysis, foraging behavior and communication in bees and other social insects, and the evolution of the bee dances. Attention is paid to other groups of animals where comparisons illuminate the biology of the honeybee. There are several ways in which this massive work can be studied with profit. One can read the chapter summaries in sequence and obtain a lucid introduction to the subject, although Martin Lindauer's *Communication in the Social Bees* (Harvard University Press, 1961) remains superior in that special regard. One can browse among the excellent illustrations and tables, pick experiments almost at random, and pleasantly absorb thereby the von Frisch style and spirit. The specialist, of course, will read with care the definitive treatment of every topic. Although von Frisch attempts to cover all of the literature, his emphasis is naturally on his own work and that of the large and distinguished group of students and research associates who began studies on the honeybee under his direction, from Beutler, Jacobs, and Rösch in the early years at Rostock and Breslau to Bizetsky, Boch, Esch, Heran, Lindauer, and Renner in the later Munich periods, and many others. Martin Lindauer has been most active in advancing the subject in recent years and his own students—Nedel, Kiechle, Markl, Rathmayer, Martin, Maschwitz, Neese, Sticker—have fanned out in many new directions to give German universities a leading role in the study of insect sensory physiology and behavior.

"The life of bees is like a magic well," von Frisch said in an earlier work. "The more you draw from it, the more there is to draw."

Young biologists should contemplate the broader truth behind this simile. It is the current fashion to measure the importance of a discovery solely by its generality; the most important discoveries, it follows, are the ones that apply to all organisms—at the molecular level, of course. But who can deny the intrinsic importance of von Frisch's work, much of which applies to only one species of *Apis*? The race to make discoveries of the greatest generality, to solve the major problems in the "mainstream of biology," does not strike me as the best research strategy to teach to students. It results in an implosive convergence of effort on a few subjects, in a sharp decline in the number of discoveries per man per unit time, and in frustration on the part of young scientists who realize too late that their own professors have already picked up the best pebbles on the beach. Von Frisch's approach represents an alternative strategy. The elegant analyses of complex systems conducted by his school are science of a high order, despite the fact that most of the individual phenomena could not possibly be of wide occurrence. The opportunities provided to beginning researchers do not decline with time, and as the subject grows, new perspectives are gained that lead, with any good fortune at all, to discoveries of a more general nature. The exemplification of this truth provides, in my opinion, the deeper contribution from von Frisch's life and work.

EDWARD O. WILSON
Biological Laboratories, Harvard University, Cambridge, Massachusetts

A Documentary of Our Recent Past

The Cosmos of Arthur Holly Compton. MARJORIE JOHNSTON, Ed. Knopf, New York, 1967. xxii + 480 pp. $10.

Rarely do all the important issues of an era come to a focus in a single life. This unusual concentration of significance did occur in the experiences of Arthur Holly Compton, whose writings, speeches, and actions reflect and in large measure engendered the atomic age. This book, which is a collection of essays from Compton's pen, is therefore more than a memorial to a distinguished scientist and man of letters: it is an authentic documentary of the events, the discoveries, the human involvement, and the deep anguish of a sensitive soul in our recent past.

Responsible for the selection of text material were the editorial advisers John J. Compton, the author's son, Edward U. Condon, Thomas S. Hall, Marjorie Johnston, and Howard Lowry, president of the College of Wooster, where Arthur Compton received his early training and where his father was a professor. I quote these scholars' characterization of the book:

> . . . It opens with brief personal reminiscences, followed by a section on the general relevance of science to human affairs. After an examination of several aspects of the philosophical background of science, there follow examples of the intellectual adventure of scientific pursuits, as seen in the author's work and in that of other scientists. The last half of the book is devoted to specific social and political issues in which science plays a role.
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> Some portions of this book have already appeared in published form, and the major previous publications have been credited in the acknowledgments. Such publications did not always have the benefit of Mr. Compton's final scrutiny, and many of them differ somewhat from his preferred or revised texts, which have been used here.

The first article is a 50-page informal autobiography, priceless for the personal touches it contains. Then follow articles on the historical and social significance of science. The vein of informality returns in a charming piece reflecting Compton's youthful interest in aeronautics, a letter written to his father at the age of 17. There are articles, notably two dealing with the problem of freedom, that have great philosophic depth. Compton's interest

in philosophy is, of course, explicit in his acceptance of a professorship of natural philosophy at Washington University in 1954 (an appointment which he reported to me with evident satisfaction). In fact the view proposed, according to which quantal uncertainty is requisite for, but does not fully encompass, human freedom, that freedom is chance plus choice and quantum theory provides only the chance, is an insight that has been borne out by developments in other fields with increasing power of conviction. A short paper entitled "Science and the supernatural" is less persuasive, probably because it has an outward purpose, for in it Compton tries to counteract certain irreligious claims made by the physiologist A. J. Carlson. Religious sensitivity marks this writing, as it does the author's character; only his attempt to justify the doctrine of the Trinity seems a little artificial. However, in this context I cannot forego mentioning my amazement at Compton's knowledge of oriental lore and oriental religions, which is evident throughout this book.

Many readers will enjoy the biographical reflections. There are recollections of Michelson, Millikan, Richardson, Rutherford, Stearns (a student and collaborator of the author's), Einstein, Davisson, and Lawrence, all personal friends of Compton's. And there is a patriotic speech on Jefferson as a scientist.

Doubtless of greatest interest are the extensive comments on the momentous affairs of the atomic age. The author, together with Fermi, Lawrence, and Oppenheimer, formed a panel which was asked by President Truman to prepare a report stating whether it could devise any kind of demonstration that would seem likely to bring the war with Japan to an end without using the bomb on a live target. The conclusion, submitted on 16 June 1945, was negative. Many people have wondered how a man of Compton's moral and religious convictions arrived at the formidable decision to drop the bomb on a city. The reasons are given in article 28, entitled "On the use of weapons," and they will impress posterity.

The book needs no praise from any reviewer. It is monumental and will stand among the great personal documents of all time.

HENRY MARGENAU
Departments of Physics and *Philosophy*, *Yale University*, *New Haven, Connecticut*

Pictures from the Scott Expeditions

Edward Wilson's Birds of the Antarctic. BRIAN ROBERTS, Ed. Humanities Press, New York, 1967. 191 pp., illus. $17.50.

Ornithological work in polar regions has presented two quite different challenges. One is to study birds in an individual-rich but species-poor avifauna. The other is to meet a climate of a severity unsurpassed on the globe. Remarkable, talented men have accepted these challenges, and Edward Wilson is an outstanding example. His personal influence and practical contributions to Scott's two antarctic expeditions (*Discovery*, 1901–04, and *Terra Nova*, 1910–12), on which he served as surgeon and zoologist and, on the second, chief scientist, have obscured his ability as an artist and, still more, as an ornithologist.

Wilson's trip with two companions to Cape Crozier to study emperor penguins nesting in the dark, cold (−40° to −70°F), and blizzards of an antarctic winter has been called "the hardest journey ever made" and "one of the most gallant stories in polar history." Wilson has been called the most gifted ornithologist ever to serve in south polar explorations. It has also been said that if he had lived (he died with Scott on their return journey from the pole in 1912) he would have been one of the foremost bird artists of his day.

In expeditions of an earlier period, sketches and paintings often filled the function that specimens and photographs have now largely taken over. Wilson collected many specimens, and some pioneering photography was done on the Scott expeditions, but his sketching and painting, done under extremely difficult conditions, formed an important part of the scientific results of the expedition.

Included in this volume are a summary of Wilson's life, extracts from his diaries, including his account of "the worst journey in the world," a bibliography of his writings and one of writings about him, and a list of manuscripts and pictures, most of them from the Scott Polar Research Institute at Cambridge, consulted by the editor. But this text is merely a frame in which to present a selection of Wilson's pictures. Besides those used to embellish the text, there are more than 300, in 60 pages of color and 42 of monochrome. They range from pencil sketches of petrels in flight and penguins active and at rest to color details of heads and feet of albatrosses, from pencil studies of icy scenery to watercolors of emperor penguins on their breeding grounds. There is intimate detail and scenic splendor; Wilson has caught the very feel of ice, snow, and sea, and his birds live.

This volume provides a footnote to history. It is also an important part of the permanent record. Not least, it is a handsome book of beautiful pictures.

AUSTIN L. RAND
Field Museum of Natural History, Chicago, Illinois

A Record of Accomplishments

Nobel Lectures. Physiology or Medicine, 1901–1921. Published for the Nobel Foundation by Elsevier, New York, 1967. xii + 563 pp., illus. $85 for the 3-volume set Physiology or Medicine.

Each year since 1901 the Nobel Foundation has published *Les Prix Nobel*, which contains all Nobel Lectures of that year, in the languages in which they were given. Short biographies of the laureates are also included. The Elsevier Publishing Company has now published, in English, the Nobel Lectures for 1901–1962, organized by subject categories, Physics, Chemistry, Physiology or Medicine, Literature, and Peace. The appearance of the present volume marks the completion of the three scientific series, consisting of three volumes each.

The publication of these volumes is justified by the publisher on the grounds that the articles will be more readily accessible to those who wish to follow the development of only one, or a few, of the categories. The presentation addresses and biographies accompany the articles.

Sixteen lectures are included in this volume. Two each were presented in 1906 and 1908; two laureates, Finsen (1903) and Bordet (1919), did not deliver lectures, and prizes were not awarded in 1915–1918 and 1921. The list of names is sufficiently impressive to justify the publisher's statement that