molecular explanation for the genetic role of that substance. In order to show how the genetic function that DNA was eventually recognized as filling came itself to be clearly defined, they have described in addition the origins of knowledge of the function of the nucleus in cells, the early theories that postulated a material basis for inheritance, and the foundations of Mendelian genetics, among other topics. In a chapter on the genetic code they extend the story almost to the present day, and, not stopping even here, they finish with a "prologue to the second century." Portugal and Cohen have attempted to tell this story so that it will be comprehensible to readers with an elementary knowledge of chemistry and biology.

The general objective of this book, to elucidate the historical roots of scientific developments that are still at the center of current research, is laudable. Historians of science have devoted a disproportionate amount of their effort to earlier stages in the emergence of modern science, leaving conspicuous gaps between their concerns and the memories of living scientists. Portugal and Cohen's book demonstrates, however, that closing such gaps can be a difficult undertaking. The most prominent characteristic of *A Century of DNA* is its unevenness. Not only do the chapters vary considerably in quality, they differ in approach and style. Chapters that concentrate on the work of a single individual, such as those on Miescher and on Albrecht Kossel, integrate the scientific work with biographical details in such a way as to provide vivid portraits of the scientific personalities of their subjects. Other chapters, however, are almost entirely summaries of the flow of investigations, with personal recollections too sparse to provide real insight into science as "a human exercise in which individuals act and interact."

The broad early chapters—on the role of the nucleus, early theories of heredity, and the evolution of modern genetics—are the least satisfactory parts of the book. In most respects these accounts are less coherent and less cogent than previously existing historical treatments. They reveal the thinness of the authors' knowledge of 19th-century biology. Later chapters are better focused, based on more comprehensive arrays of primary sources, and more persuasive in their interpretations.

As the preface of *A Century of DNA* indicates, its subject matter overlaps that of two other recent historical studies. Robert Olby's *The Path to the Double Helix* provides more detailed accounts of some aspects of the story, especially the development of the concept of the macromolecule, the use of x-ray diffraction techniques, and the events immediately related to Watson and Crick's discovery. On these subjects Portugal and Cohen contribute only a more compact, somewhat simplified story. They do, however, supplement Olby's account by devoting considerably more attention to investigations of the chemistry of the nucleotides composing DNA, especially to the work of Phoebus Levene and Alexander Todd. A chapter of another recent book, Joseph Fruton's *Molecules and Life*, covers most of the subject matter of *A Century of DNA*. Although much shorter, Fruton's treatment is more authoritative and more even in its treatment of the various periods. Fruton, however, gives none of the biographical details that enliven Portugal and Cohen's narrative.

Portugal and Cohen's chapter "The three-dimensional structure of DNA" is an eclectic summary of recent versions of the history of the double helix as told by Watson himself, by Anne Sayre in defense of the late Rosalind Franklin, by Olby, and by others. Concerning the disputes over the roles of the participants in these events, the book balances opposing statements without attempting to resolve the differences.

In their preface Portugal and Cohen make the admirable declaration, "We have tried to present [the] ideas as scientists at the time regarded them, rather than evaluating them with hindsight. Our purpose is to show the important developments in the area and their effect regardless of whether subsequent events proved them to be in error." Just prior to this, however, they have written, "The organization of our book is based on the answer to a single question: why did it take more than a century of research before scientists properly understood what DNA was and what it did within the cell?," and in fact the text is replete with the kind of hindsight evaluations the authors reject. Haeckel, for instance, is described (p. 33) as having "redeemed himself" for proposing the erroneous monera hypothesis by suggesting that the nucleus provides for the transmission of hereditary characters, and the chapter "Early theories of heredity" consists largely of a selection of those views of 19th-century biologists that can be seen in retrospect as partial statements of principles that became established after 1900. Hindsight comments are less conspicuous in the chapters on more recent developments but are not altogether absent.

With the starting point Portugal and Cohen took it was almost inevitable that they would select and analyze events of the earlier periods from the perspective of how they would cumulatively contribute to the climactic developments of the 1950's. Scientific events are shaped, however, not by what is to come long afterward but by what has preceded them. The way in which Portugal and Cohen posed their central question ruled out in advance a truly historical interpretation of the early stages in their story.

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Researches in Denmark

The Carlsberg Laboratory, 1876–1976. H. HOLTER and K. MAX MØLLER, Eds. Published by the Carlsberg Foundation. Rhodos, Copenhagen, 1976. 448 pp., illus. Dan. Cr. 125.

The Carlsberg Laboratory in Copenhagen, although a relatively small institution, has been one of the world's great centers for research in such fields as protein chemistry, cytochemistry, and genetics of yeast. This handsome and substantial volume, celebrating the centennial of the laboratory, contains much that is significant for historians of science. The laboratory was a direct outgrowth of the Carlsberg Brewery and was established in 1876 by the highly successful brewer J. C. Jacobsen, who set it up under the Carlsberg Foundation, with a board of trustees elected by the Royal Danish Academy of Sciences and Letters. Jacobsen emphasized the commitment of the foundation to the advancement of fundamental science and stipulated that "no result of the activities of the institute which is of theoretical or practical importance may be kept secret." This liberal policy has always remained in force. The laboratory in fact closely adjoined the brewery, and Jacobsen correctly expected that the work of the latter would benefit greatly by the discoveries and the advice of the researchers in the laboratory.

From the beginning there were two major departments, of chemistry and physiology. The first director of the chemistry department (1876–1900) was Johan Kjeldahl, now remembered chiefly for his widely used method of nitrogen analysis. His successor, S. P. L. Sørensen, profoundly influenced chemists and biochemists everywhere by developing the theory of the *p*H scale and

the various buffer systems that permitted accurate *p*H measurements. His great work on the physical chemistry of proteins was of central importance in establishing the fact that proteins were definite large molecules, subject to the general laws of chemistry. The emphasis of the laboratory on protein and enzyme research has continued under his successors, K. U. Linderstrøm-Lang and M. Ottesen. In the years after 1945 under Linderstrøm-Lang, a man of brilliant and many-sided gifts, the laboratory became a mecca for protein chemists from around the world.

The physiological department, in its early days under E. C. Hansen, made important contributions to the biology of yeasts and later of higher fungi; the work on yeasts not only was important for science but was of great practical significance for the brewery. Hansen's successor, Johannes Schmidt, also a botanical researcher, became famous as an oceanographer; his studies on the life history and breeding places of the Atlantic eels, and later his circumnavigation of the globe (1928–30) in the *Dana II*, were particularly notable for contributions to biological and physical oceanography. Øjvind Winge, who succeeded Schmidt, became one of the world's leading yeast geneticists; his successor, Heinz Holter, one of the editors of the present book, is eminent in histochemistry and cytochemistry.

The major part of the book is devoted to biographies of these men and others who have played an important role. Several of the biographies appeared earlier in the *Comptes Rendus* of the Carlsberg Laboratory. Here they are sometimes shortened from the original versions, but it is of great value to have them all together. One chapter is devoted to personal recollections of the laboratory by visitors who have worked there; some of these recapture the atmosphere of the place and the people in it very well indeed. I liked particularly the recollections of R. D. Hotchkiss, but all are well worth reading. The final chapters recount the recent reorganization of the laboratory, under financial and other pressures, and its transfer from the Carlsberg Foundation to the United Breweries—a change that greatly enhances the scope of applied research in the expanded laboratories, but leaves an active center of basic research that maintains its continuity with the past.

The book is well printed, with numerous interesting photographs of people and activities, and with a number of well-reproduced color plates. The text is written for the informed public, for readers with some basic background in science. Except in a very few places it requires no specialized technical knowledge for its understanding. The book is a worthy record of a great laboratory.

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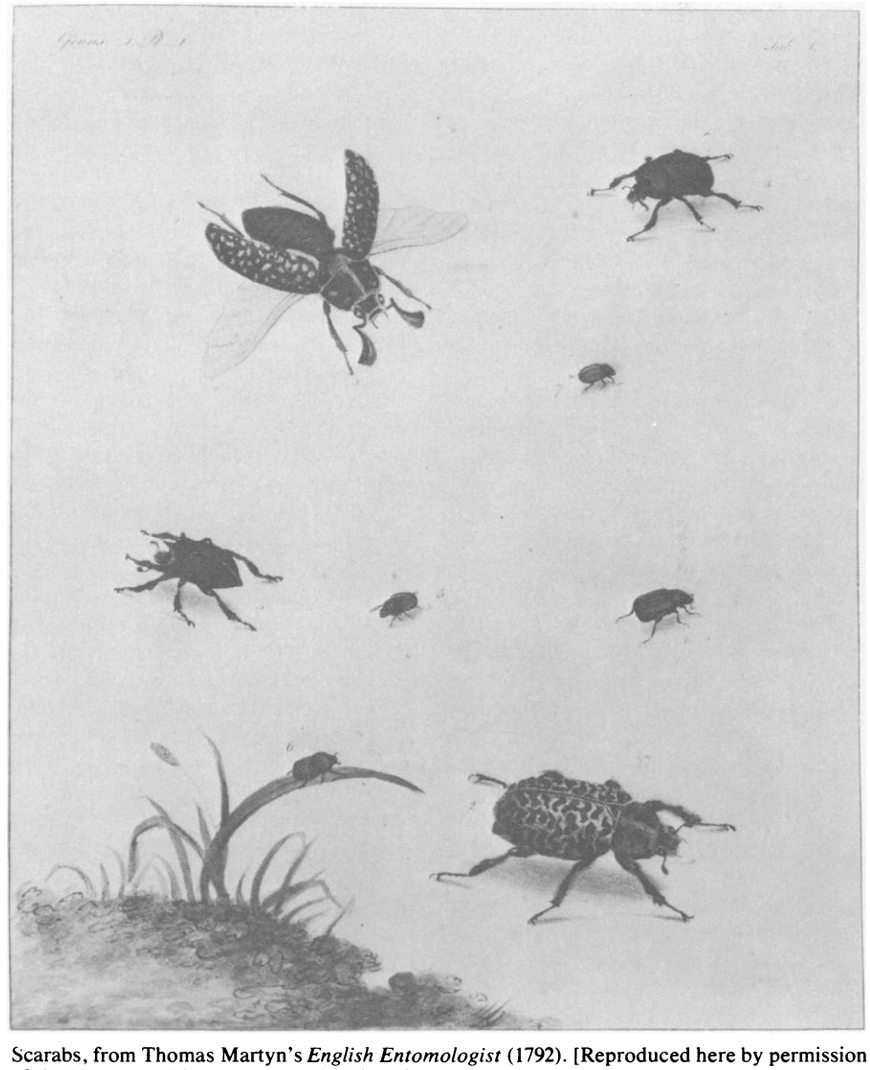
Pictorial Works

Zoological Illustration. An Essay towards a History of Printed Zoological Pictures. DAVID KNIGHT. Dawson, Folkstone, Kent, and Archon (Shoe String Press), Hamden, Conn., 1977. xii, 204 pp., illus. $17.50.

Fine illustrated zoological works fetch astonishingly high prices on the rare book market; even in facsimile editions they cost far more than most honest scientists, historians, and animal lovers can pay. Our only consolation—as David Knight points out in this book—is that when these books were first published we could not have afforded them either.

Anyone who covets or is lucky enough to own some of these handsome works will find much of interest in this book. As one would hope, Knight gives plenty of samples of zoological illustrations, taken from several genres of books on animals published between the late 15th century and the early 20th century (that is, between the invention of printing in the West and the introduction of photographic methods for printing illustrations) and notes the advantages and difficulties associated with the various processes used to reproduce zoological drawings. He describes a good number of zoological works and supplements his text with long lists of other illustrated books and journals and secondary sources. The emphasis is decidedly on English books and on treatises on vertebrates (especially birds); it is not clear whether



Scarabs, from Thomas Martyn's *English Entomologist* (1792). [Reproduced here by permission of the Houghton Library, Harvard University]