A Leader in Physics

Enrico Fermi, Physicist. EMILIO SEGRE. University of Chicago Press, Chicago, 1970. xii, 276 pp. + plates. $6.95.

The title of this book is singularly appropriate. Fermi was a great man, a man of integrity, deep wisdom, and sensitivity. His real life and his whole life, however, was physics. There was nothing that he ever experienced, the honors of the Nobel prize, the academy elections, the honorary degrees, the attentiveness of senators and presidents, that compared with the pure, unadulterated pleasure he found in doing battle with nature, in understanding physical phenomena. Although he never shirked responsibilities either in academic life or in national affairs, he regarded all these things as distractions from his real purpose in life—doing physics.

At the first Rochester conference on high energy physics following Fermi's death, I. I. Rabi rose and said: "Fermi may have been the last one who was not an experimentalist or a theorist, but simply a physicist; we shall all miss his wisdom."

Segrè's description of Fermi's early life and his involvement with and commitment to physics is extremely interesting to those of us who knew Fermi only after he was an acknowledged scientific giant. The intensity with which Fermi attacked the problem of learning physics as a young man stayed with him throughout his life. He would in later years decide he wanted to learn a particular subject, say group theory. He would spend several hours a day (usually the early hours in the morning, because he was an insomniac) for some weeks mastering the subject. Although Segrè refers to his reading books, and the exceedingly interesting and revealing correspondence between Fermi and his friend Enrico Persico contained in the appendix often mentions explicit texts, one always had the feeling that he essentially reinvented everything for himself.

The way Fermi almost single-handedly raised Italian physics from obscurity into worldwide prominence is somewhat underplayed by Segrè, who modestly doesn't give adequate recognition to the extremely talented group of student-colleagues Fermi attracted, among whom Segrè himself played a prominent if not predominant role.

It is not too clear from the book what the relation between Fermi and his students was during the Italian years. For the most part, the age differences were apparently very small. Perhaps it was a result of the wartime Manhattan Project associations or maybe it was just Fermi's personality, but for those of us at Chicago who had the privilege, being Fermi's student was marvelous. There was an exceptional group of students right after the war at Chicago, many of whom had worked on the Manhattan Project, and there were very few caste distinctions between faculty and graduate students. Fermi himself took very few Ph.D. students (Geoffrey Chew and I were the first theoretical students he ever had in the United States) but, as Segrè recounts in detail, he was very much involved in the training, both formal and informal, of a very large number of students. Fermi often complained that he never had been able to establish a "school" as others like Oppenheimer and Uhlenbeck had done. History will record that he was mistaken; one need only examine the record of Chicago graduates from 1946–54 and the style that runs through their work.

Fermi's role as the intellectual leader at the Institute for Nuclear Studies (now called most appropriately the Enrico Fermi Institute for Nuclear Studies) is emphasized by Segrè; how extensive it was can only be appreciated by those who were there to see it. Fermi had the truly exceptional gift of concentrating all of his attention on any problem under discussion, and his always constructive critical evaluation of all seminars and colloquia gave a remarkable vitality to the institute.

Segrè understands and describes very clearly the outstanding characteristics of Fermi's theoretical work: clarity and completeness. Fermi's paper on the theory of beta decay should be required reading for all physics Ph.D.'s. The problem is stated clearly, the theory is developed in a simple, straightforward way, comparison with experiment is made, and definite conclusions are reached. There are no loose ends, no promises of future publications, no unsubstantiated claims. He was content to leave abstraction to those he called "the high priests," a term he used with a little contempt but with perhaps a little of the envy one has for people who do things one cannot oneself do well. Fermi was not modest, however, and felt that he did enough things superlatively well that he didn't have to worry about the accomplishments of others. Nor did he ever feel it necessary to put people down.

One cannot quarrel with the decision of an author as to how to present his subject. I wish Segrè had been less impersonal, especially about the exciting days of the early '30's in Italy when both he and Fermi were young. Of course this is the selfish reaction of one who knew Fermi well as physicist particularly during the last ten years of his life. Segrè has succeeded admirably in describing Fermi's entire scientific career, and this book is strongly recommended.

M. L. GOLDBERGER
Institute for Advanced Study, Princeton, New Jersey

Cartographic Embellishments

Animals and Maps. WILMA GEORGE. University of California Press, Berkeley, 1969. 238 pp., illus. $9.50.

Prospective purchasers should be warned at once that, although the author is a zoogeographer, *Animals and Maps* is primarily a history of the small pictures of animals with which early cartographers decorated their maps, and is not a zoogeography. As a contribution to a special aspect of the history of maps, the book should interest both cartographers and some general readers. It is fairly well written, is well produced (except for some illustrations), and has a nine-page reference list and a good index. However, many of the reproductions of old maps, although attractive at first glance, are disappointing in detail. They are drastically reduced and printed in halftone. The result is that most of the lettering and many of the animals on them cannot be made out at any magnification. For example, the author says, ". . . Ribeiro had filled the South American continent with some fifteen different types of animals (fig. 10.1)" and "among the animals on Ribeiro's map there occurs an animal with every appearance of an armadillo . . ." but, referring to figure 10.1, I can distinguish only three animal figures on it, not including an armadillo.

The book does have the appearance of a zoogeography. The first figure in it is an outline map of the now-accepted faunal regions; six of the ten chapters have as titles the names of the regions; and zoogeographic passages

are inserted at intervals. This zoogeographic material should help cartographers understand the distribution of animals pictured on old maps, but it is hardly a contribution to zoogeography.

Early cartographers did place many animals in the proper parts of the world, and the details they recorded are indeed the raw materials of zoogeography. Whether or not accumulation of unorganized details is in itself zoogeography is a matter of definition, but it is not what we think of as zoogeography now. Zoogeography is or ought to be the putting together of the details into significant patterns. The old cartographers did not do this, and to force the details they knew into patterns discovered later, as is done in this book, seems to me to distort history.

The story of the yale exemplifies the methodology of the book. Accounts of the eale or yale date from Pliny, who described it as being the size of a hippopotamus but horned, with one horn pointing forward and one back. George devotes more than a page to different imaginary versions of this animal on different maps, and argues that it may have been a water buffalo. I do not find the argument convincing, but at least it is legitimate fun, as cartographic history. However, she then says, "On these early maps . . . the ethiopian and oriental regions are . . . distinguished from one another by the appearance of the yale only in the oriental region." But surely the old map makers did not mean to characterize zoogeographic regions. They simply put the yale, which was unknown to them whether or not it was a water buffalo, where Pliny had said it was.

The book is not even a satisfactory history of the growth of knowledge about animal distribution. Such a history should be based on all available sources, not just on the details that caught the attention of cartographers.

The zoogeographic maps (figs. 3.11, 5.9, and 7.14), which are reprinted from an earlier work by the same author, are scarcely useful or pertinent to the text. They are decorated with crude animal figures, some of which are impossible for even a zoologist to recognize; they are not adequately explained in the text; and some of the arrows on them, intended to show directions of dispersal, are at best ambiguous.

I recommend this book (with reservations) only to cartographers and others interested in the history of animal pictures on maps—this history does have an interest of its own—but I do not recommend it to zoogeographers.

P. J. DARLINGTON, JR.
Museum of Comparative Zoology,
Harvard University,
Cambridge, Massachusetts

Light Reactions

Photosynthesis. EUGENE RABINOWITCH and GOVINDJEE. Wiley, New York, 1969. xiv, 274 pp., illus. Cloth, $8.95; paper, $5.95.

This book has little resemblance to the three-volume *Photosynthesis and Related Processes* (Academic Press) by the senior author, an encyclopedic monograph still serving workers in the field as a treatment of the literature before 1956. The new book is, as is noted in its preface, "suitable for introduction into the field of photosynthesis for students with varying backgrounds —from physics to plant physiology."

There are 19 short chapters, most of them written in a chatty style extended even into sometimes corny but effective analogies which any teacher will recognize as memory implants. It is organized for the guidance of the reader (with some sacrifice to redundancy) rather than according to the cold logic of its subject. Some 80 figures, many in diagrammatic style, support the text. Where mathematical relations are given, their symbolism and interpretation are carefully explained. There is a historical flavor injected by the citation of names and places. The bibliography is limited to citations of books, symposia, and reviews, with no listing of particular articles discussed. In short, the book is oriented toward instruction with some sacrifice of scholarly niceties.

The first five chapters present the ancient history and biological significance of photosynthesis and an introduction to energetics. Thereafter the reader is carried quietly into ideas of structure, overall kinetics, quantum yield and action spectrum, energy migration among pigment molecules, the evidence for two pigment systems and photochemical reactions, the reduction of carbon dioxide, and photophosphorylation.

In order to manage all this in a short treatment, the authors have made certain sacrifices. The reader may feel that he is being fed more biophysics and less biochemistry than he would like, and he will find only isolated crumbs on bacterial photosynthesis.

Of several possible criticisms, one is of sufficient interest that it will stand elaborating. In their necessarily simplified historical treatment the authors exaggerate the contributions of their former colleague Robert Emerson and ignore other critical contributions.

The modern period of photosynthesis research dates from 1960, when there were made the first serious suggestions that there might be two independent light reactions. There were already available two observations now taken as evidence. One of these came from Lawrence Blinks in his 1955 report on the phenomenon of chromatic transients, the occurrence of transient changes in the rate of oxygen exchange accompanying changes in wavelength of illumination. Blinks's experiments are a monument to raw curiosity in science, and to omit them, as the authors have done, is to lose some of the drama they sought to inject.

The second piece of evidence was the "red drop," the drop in quantum yield at long wavelength. The authors properly attribute to Emerson and Charlton Lewis the first demonstration of and concern for this anomaly. But there was equal, and, in some respects, even more dramatic evidence from Francis Haxo and Blinks, and this also has been ignored. Emerson tenaciously pursued the anomaly until he discovered the phenomenon of enhancement, an apparently synergistic effect between certain wavelengths of light. He clearly identified the effect with some special contribution to photosynthesis made by light absorbed by accessory pigments, but, contrary to the authors' statements, it was not he who suggested that photosynthesis involves two photochemical reactions. In 1960, at the Johns Hopkins Light and Life Symposium, there were three separate proposals for independent photochemical reactions: by Bessel Kok and George Hoch, by Robert Hill and Walter Bonner, and by C. S. French. The Kok and Hoch proposal was most directly supported by experimental data, but it was the potential diagram proposed immediately thereafter by Robert Hill and Fay Bendall which became the Z-scheme in the current dogma of photosynthesis.

The authors properly dedicate their book to the memory of Robert Emerson. His clear statement of the special and necessary role of accessory pigments