The fact that Aitken does not explicitly take the next step in his argument may relate to his selection of sources for both his history and his theory. In Aitken's view, general ideas or metaphors make these new conversions or blends possible by "serving always to organize or give meaning to information that would otherwise remain disjunct and without structure" (p. 44). In his history, the idea of syntony organized the perceptions of the three translators. Perhaps Aitken could show that intellectual influence on the translators by presenting evidence from their personal papers. But his history rests largely on information from professional journals, government records, and biographies. He uses these sources with care and intelligence. In reassigning priority of invention to Lodge (p. 123), for instance, he constructs a plausible argument based on a wide range of materials. But an attempt to explore the conditions of creativity that makes no use of primary sources, such as personal papers, cannot be wholly satisfactory or convincing.

Nor does Aitken show a broad acquaintance with current literature pertinent to his work. The writings of such historians of science as Arnold Thackray, Paul Forman, and Barry Barnes suggest that science was not as autonomous as Aitken portrays it as being. Barnes's work on the role of metaphor in science would seem particularly useful for Aitken's purposes. Aitken reveals more familiarity with current work in the history of technology but neglects Thomas Hughes's work on technological systems and on the relations between science and technology and Elting Morison's sociopsychological interpretation of creative invention. In economics, the work of the post-Schmookler "technological change" school (of, for example, Richard Nelson, W. Paul Strassmann, Edwin Mansfield, or Raymond Vernon), which explores relations between technology and economics, is ignored. In addition, Aitken misses a number of works from the Tavistock Institute (of, for example, Howard V. Perlmutter or Eric Trist) that treat economics as a system of social action. Aitken is a translator, though, and translators are never as specialized as the enterprises they bridge.

Aitken's exploration of the creative relations between science, technology, and economic activity, which is his fundamental concern, is a valuable contribution. His theory points to the importance of technological anomalies for scientific paradigms, alerts us to the creative nature of both technological and economic activity, identifies a translator role, and, most important, suggests an effective way of thinking about the full creative process of innovation. Aitken's analytical isolation of the translator role in that process and his suggestion that a translator's perception of relevant information is as important to the process as the information or knowledge itself clearly carry too many historical and current implications to explore in a review. His book is bound to spark much thought and discussion.

ROBERT BELFIELD
Department of History and Sociology of Science, University of Pennsylvania, Philadelphia

Improving Plant Yield

CO_2 Metabolism and Plant Productivity. Proceedings of a symposium, Madison, Wis., June 1975. R. H. BURRIS and C. C. BLACK, Eds. University Park Press, Baltimore, 1976. xiv, 432 pp., illus. $39.50.

The fifth Steenbock symposium provided an opportunity for many of the world's leading researchers studying CO_2 metabolism in plants to assess the limitations of photosynthetic productivity in terrestrial plants and to propose researchable methods of increasing such productivity. The 26 symposium papers included in this volume address all major aspects of CO_2 metabolism in plants. The papers are authoritative and well conceived. Some are straightforward summaries of research in progress, and others describe one or two decades of effort by individual laboratories to improve crop yield by using conventional plant breeding approaches to increase the photosynthetic capacity of plants.

Wallace and colleagues have analyzed dry bean genotypes that differ in CO_2 assimilation rate and have concluded that the polygenic regulation of the process makes breeding for CO_2 assimilation rate practically ineffective. Zelitch has come to the same conclusion working with tobacco. Ogren and Moss have screened thousands of seedlings of agronomic plant species that have been treated with conventional mutagens without discovering a single mutant that was useful in a breeding program for photosynthesis.

These perplexing results have spawned other innovative research. Bjorkman has attempted to cross related plant species that have different CO_2 assimilation pathways. Zelitch has used tissue culture techniques in an attempt to generate phenotypes that have more efficient photosynthesis and altered daylight respiration. Ogren is attempting to regulate CO_2 assimilation and daylight respiration by chemical and genetic modifications of the primary enzyme in the pentose phosphate cycle.

As the efforts to discover new genetic or chemical tools to modify the rate of photosynthetic CO_2 fixation continue, several physiologists are questioning the extent to which the rate of CO_2 assimilation limits a plant's productivity in the fields. Loomis and colleagues and Wallace and colleagues correctly argue that, regardless of photosynthetic capacity, it is the utilization of the photosynthate by the crop in such processes as leaf expansion, fruit growth, nitrogen fixation, and respiration that ultimately determines yield. Moss shows how the capricious environment may prevent the realization of the genetic potential for photosynthetic CO_2 assimilation in current crop genotypes.

The volume offers a balanced presentation of the status quo and a lucid discussion of the challenges confronting researchers studying photosynthetic CO_2 metabolism. The hypotheses framed by the contributors will undoubtedly tempt new, bright minds to take up the challenge of increasing the photosynthetic productivity of crops.

G. H. HEICHEL
U.S. Agricultural Research Service, St. Paul, Minnesota

Scattering Phenomena

Optics of the Atmosphere. Scattering by Molecules and Particles. EARL J. MCCARTNEY. Wiley, New York, 1976. xviii, 408 pp., illus. $24.95.

Not long ago optics meant to most people the physical properties of visible light, radiation that we could see. During World War II the military developed infrared night vision devices, and, more recently, vidicons have been developed that can sense ultraviolet radiation and present an image of it on a television screen. So optics nowadays encompasses the entire spectrum of electromagnetic radiation, from the extreme ultraviolet to the far infrared. With the development of optical sensors, new fields of environmental research, called remote sensing or optical probing, have sprung up. Optical sensors enable us to detect and monitor pollutants in the atmosphere, to sense the vertical distribution of atmospheric constituents, or of their temperatures, and to peer down through the atmosphere from a satellite to sense earth resources.

With the new remote-sensing instruments probing the atmosphere (or attempting to see through it), there has also occurred a vigorous revival in the atmospheric sciences.

The last half dozen years have seen the appearance of several good reference books (those by Goody and by Kondratyev for example) that deal with atmospheric radiation processes—chiefly the processes of emission, transmission, and radiative transfer—in which light is absorbed and reemitted. The present book addresses itself primarily to optical scattering, the process during which light rays are changed in direction by reflection from the particles or molecules of the atmosphere: the light is not absorbed, it is scattered. Optical scattering is a complex phenomenon that depends on the wavelength of the incident light and on the abundance of the particles, their sizes and shapes, and the range of size distributions. When the size of the scattering particles is small relative to the wavelength of the light, the scattering is described by a classical theory worked out by Rayleigh in 1871 and called Rayleigh scattering. When the wavelength of the light is of the same order of magnitude as the diameter of the scattering particles, a much more complicated theory applies. It is generally ascribed to Gustav Mie and is called Mie scattering. When the scattering particles are larger than the wavelength of the light, as with raindrops or fog particles, the classical laws of optical reflection from surfaces can be applied, and we can speak of white clouds reflecting sunlight or light diffused by rain and fog. It is hard to believe that until Rayleigh introduced his theory just over a hundred years ago we had no proper understanding of or explanation for even such everyday matters as why the sky is blue or why sunsets are red. (Optical scattering theory also explains why on hazy days in places like Los Angeles the sky is brown and the sunsets murky.)

This is the first book I have seen that includes a systematic treatment of Rayleigh scattering, Mie scattering, and scattering by nonspherical particles such as ice crystals or atmospheric haze. The standard theory is covered in some detail, and the author has read and digested the vast literature on atmospheric aerosols, haze, smokes, and pollutants, much of it empirical and in need of interpretation by someone versed in scattering theory. The book is well documented, with references as recent as 1975. It is intended not for the casually interested layman but for those who are engaged in research on the environment, atmospheric phenomena, remote sensing, meteorology, or just plain optical physics, who will find it authoritative and useful.

JOHN N. HOWARD
Air Force Geophysics Laboratory, Hanscom Air Force Base, Massachusetts

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