many other earlier scholars of the subject.

In chapter 4, which concludes the background for the main subject of the book, a thorough discussion is given of the origin of the term "alchemy" in which all the different theories of Greek (*chymia, chēmeia,* and *chymos*), Egyptian (*kmt*), and even Chinese (*chin-i,* as proposed recently by Mahdihassan) origin are considered. The author concludes that *chēmeia-chymia* is related to both *chymos* and *chyma* and that "at the early stages there was no very clear differentiation between juice-extraction and smelting or alloying" (p. 89).

Chapters 5 through 17 are devoted to a systematic "history" of alchemy in antiquity, beginning with two chapters on Bolos of Mendes, whom the author considers to be the founder of systematic alchemy, and ending with the important figure Zosimos, with whom theory and practice became indissolubly wed, and the last of the alchemists of antiquity like Stephanos. The author stresses the presence of the two contending schools of Jewish and Egyptian alchemy, the importance of Iranian influences as seen in Ostanes and Mithraic elements, and the crucial role played by the craft guilds throughout this period of the genesis and development of alchemy. In many of the chapters new material has been brought together for the first time in English, and some of the alchemical figures like Bolos and Maria the Jewess are seen more clearly here than in any of the standard histories of alchemy.

Despite its rich documentation and historical analysis, this work falls short in explaining the symbolic significance of alchemy. Of the four basic levels of meaning in alchemy, the cosmological, the psychological, the medical, and the physical, the author limits himself mostly to the last and considers the modern conception of nature the only valid background against which the teachings of alchemy can be judged. It is strange that after the appearance of works by T. Burckhardt, W. Pagel, and M. Eliade the author should not consider seriously the symbolic significance of alchemy and the world view which makes of it something completely other than a protochemistry. Lindsay does recognize the purely quantitative nature of modern chemistry and writes, "Modern chemistry was not just alchemy without the nonsense; it was alchemy tamed, reduced wholly to a quantitative level, and thus giving up its ghost" (p. 387). Moreover, in his conclusion he regrets the fact that the quantitative Galilean science did not take into consideration the intuitions of alchemy. But he refuses to judge alchemy in terms of its own universe with its multiple levels of meaning rather than in terms of the "two-dimensional" world of post-Galilean science.

A surprisingly large number of misprints does not detract from the value of the book with its rich documentation of the early history of alchemy and its bringing together of material not easily available in the most commonly used works on the subject.

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Practical Botany

Genetic Resources in Plants. Their Exploration and Conservation. A conference, Rome, September 1967. O. H. FRANKEL, E. BENNETT, R. D. BROCK, A. H. BUNTING, J. R. HARLAN, and E. SCHREINER, Eds. Published for the International Biological Programme by Davis, Philadelphia, 1970. xxii, 554 pp. + plates. $17.50. IBP Handbook No. 11.

This volume is dedicated to N. I. Vavilov, the father of modern crop plant exploration. An appendix by D. Brezhnev of the Vavilov Institute of Plant Industry, Leningrad, contains the encouraging news that the research on cultivated plants which was broken off at the time of Vavilov's banishment and death has now been resumed on a broad scale with the help of modern genetic techniques.

The book itself contains 44 chapters, each of them written by a different author, except for three by Sir Otto Frankel and two by his associate editor, Erna Bennett of the U.N. Food and Agriculture Organization (which sponsored the symposium). Most of the authors are well-known authorities in the genetics of cultivated plants and forest trees or in the field of plant exploration and ecology. They represent 13 nations.

Most of the chapters are brief digests of the principal facts about their topics. The longest are those of Frankel on "Genetic conservation in perspective," of H. G. Baker on "Taxonomy and biological species concepts in cultivated plants," of E. Bennett on "Tactics of plant exploration," of I. A. Watson on "The utilization of wild species in the breeding of cultivated crops resistant to plant pathogens," and of J. F. Harrington on "Seed and pollen storage for conservation of plant gene resources." These titles give a good idea of the scope of the book. In addition to general articles, there are brief treatments of gene pool explorations in wheat, maize, potatoes, peas, sweet potato, cotton, temperate zone tree fruits, and various groups of forest trees.

Some of the theoretical concepts emphasized are the following: The hypothesis of Vavilov, that the original center of cultivation of a crop plant species can be recognized because it contains the greatest amount of variability in modern times, is criticized by both Harlan and Zohary, who point out that various factors, particularly introgressions between crop species and their wild relatives, accompanied by a low intensity of varietal selection, can build up large secondary centers of variability. Baker makes a strong plea for biosystematic treatments of cultivated plants and their wild relatives, in contrast to treatments that are based solely on gross morphology. He emphasizes the fact that characters of flowers, fruits, and seeds, which in wild species are usually conservative because of strong selective pressures that maintain character combinations favoring seed dispersal, can be drastically altered in a short time by artificial selection for characteristics that are desirable to man and that reduce natural seed dispersal, a characteristic that is undesirable for the cultivator. Consequently, taxonomic systems that are based upon these characteristics can give an exaggerated impression of the differences both between cultivated species and their wild relatives and between different varieties of a cultivated species. J. G. Hawkes points out difficulties in the way of rigid applications of the species concept, and recommends a pragmatic approach that will be most useful to the breeder dealing with each particular group.

Several factors affecting the adaptation of crop plants to their environment are listed by J. P. Cooper, and W. Hartley points out that artificial selection has extended the range of most crop species far beyond that of their wild relatives.

On the practical side, Bennett gives careful instructions on how to plan an expedition for exploration for crop

plants; and Bunting, Kuckuck, Gordon, Poissonet, and Henry explain how ecological data can most efficiently be recorded. The problems of quarantine, sanitation, evaluation, storage, and maintenance of seeds and cultures are discussed in a series of articles.

This volume has exceptional value for two reasons: it gives many cogent reasons for devoting more time, money, and human energy to exploring, making inventories of, and conserving our genetic resources of crop plants, and it is an invaluable encyclopedia of methods by which these goals may most efficiently be achieved.

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Mitochondria and Plastids

Control of Organelle Development. Society for Experimental Biology Symposium No. 24, London, Sept. 1969. Published for the Company of Biologists by Academic Press, New York, 1970. viii, 524 pp. + plates. $17.50.

The stress in this collection of papers, from two dozen research groups, is on the development, the nucleic acids, and the transmission from parent cell to daughter of mitochondria and plastids. There are also brief discussions of protozoan killer particles, ciliate macronuclei, and cytoplasmic influences on the nuclei of protozoa, *Acetabularia*, and amphibians. Except for consideration of protozoan cortical patterns, only passing attention is paid to centrioles and basal bodies, and very little is said about the development of cilia and flagella or endoplasmic reticulum. There are relatively few surprises in choice of authors, and only two or three of the papers are of questionable quality. With occasional exceptions, the photomicrographs range from the adequate to the mediocre. This appears to be a matter partly of space constraints and quality of reproduction; some of the pictures have obviously been reduced excessively so that structures of interest are almost invisible. More annoying is the separation of photographs from text and from legends. The way the book is laid out, one must go to the end of each article to find the electron micrographs referred to in the text and then sometimes make a further search for the detailed explanation of the figures.

There emerges from the book a portrait of a lively and intriguing field that has recently passed a major take-off point. In little more than a decade, the focus of study of the development and transmission of cytoplasmic organelles has shifted substantially away from formal genetic analysis of "cytoplasmic inheritance" and spirited arguments about hypothetical "de novo" or "self-duplication" mechanisms. Important details are becoming clear about the actual modes of assembly of macromolecules into the enzyme-laden membranes within mitochondria and chloroplasts, and there are some intriguing leads concerning the assembly of other intracellular structures. But by far the most dramatic advances have been made in the analysis of nonnuclear hereditary machinery—notably the DNA, ribosomes, and related systems of chloroplasts and mitochondria. Ten years ago the existence of such components was in doubt. Now, the "bacterial-like" ribosomes of mitochondria and chloroplasts and the circular DNA of animal cell mitochondria are standard items of discussion in the better undergraduate texts. As reflected in the present book, the questions that now are central and are beginning to yield to experimental analysis include the following: How much hereditary information is there in a mitochondrion or chloroplast? Is there evolutionary or functional significance to the fact that mitochondria of higher animals seem to have less DNA-borne information than mitochondria of lower forms? Is there more than one linkage group per individual cytoplasmic organelle, and do the plastids or mitochondria in a single cell normally differ significantly in their nucleic acids? Does the apparent genetic recombination between organelles result simply from fusion of the organelles, or does it also involve the formation of recombinant DNA molecules? Which mitochondrial or plastid proteins are synthesized within the organelles and which come from outside? How does the transfer of proteins from "ordinary" cytoplasmic ribosomes to the mitochondria or plastids come about? How many separable steps in chloroplast morphogenesis can be distinguished by study of mutants or of material in which protein synthesis or nucleic acid metabolism has been experimentally manipulated? Do the inner and outer mitochondrial membranes differ in origin? Is there exchange of messenger RNA's or genetic regulatory molecules among the nucleus, the chloroplasts or mitochondria, and the rest of the cytoplasm? What does it mean that some chloroplast ribosomal RNA's can hybridize with nuclear DNA? What sorts of steps might be involved in the evolutionary transformation of a symbiotic microorganism into an organelle?

Few of these questions are answered definitively by the contributors to the book. But almost all are well posed, put in context, and presented in terms of relevant present knowledge and reasonable future perspectives. Thus, although like virtually all such books this one will soon be out of date, it seems to have come at a propitious moment and conveys a useful image of a field during a crucial and fascinating period of its history.

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A Non-Taxonomic Treatment

Principles of Paleontology. DAVID M. RAUP and STEVEN M. STANLEY. Freeman, San Francisco, 1971. xii, 388 pp., illus. $11.50. A Series of Books in Geology.

Paleontology texts have traditionally emphasized the descriptive-taxonomic side of the subject. Raup and Stanley have broken out of this mold, to concentrate on biologic principles and on the application of paleontology to the general problems of science. *Principles of Paleontology* is to be read in parallel with, or subsequent to, a systematic descriptive course. It makes no attempt to deal comprehensively with any particular problem, but highlights a large number of diverse topics, selected mainly from the newer primary literature. Early chapters deal with the specimen, ontogeny, populations, and the species. A fine discussion of the nature of higher taxonomic levels leads to a brief but lucid exposition of numerical taxonomy. Subsequent chapters include treatments of adaptation and functional morphology (including a section on theoretical morphology and computer simulation), of evolutionary patterns, and of biostratigraphy, and the book ends with a discussion of applications of paleontology