tribution (and a very important one) appears to be evidence that tritium-labeled extra univalents found after heat treatment in his grasshoppers result from genuine heat-induced depression of crossover frequency later than the major premeiotic DNA synthetic period, rather than from complete chiasma terminalization.

Several symposium participants (D. G. Catcheside; D. E. A. Catcheside; Holliday, Lindsley, Sandler, Nicoletti, and Trippa) demonstrated ingenious use of meiotic mutants to study the mechanics of the process and pointed to their potential utility.

There are many other outstanding findings, deductions, and constructive speculations offered in the volume which cannot be mentioned in a brief review. The entire symposium is probably an indispensable reading and reference source for students of genetic recombination.

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Impact Structures

Shock Metamorphism of Natural Materials. Proceedings of a conference, Greenbelt, Md., 1966. BEVAN M. FRENCH and NICHOLAS M. SHORT, Eds. Mono, Baltimore, 1968. xii + 644 pp., illus. $25.

In 1807, Thomas Jefferson wrote in a letter concerning an alleged meteorite fall: "It may be difficult to explain how the stone you possess came into the position in which it was found. But is it easier to explain how it got into the clouds from whence it is supposed to have fallen?" Sixty years ago, few imagined that the earth had been bombarded throughout history by meteorites large enough to form impact craters. Yet in the past ten years more than 35 circular terrestrial geologic structures have been described as impact structures and have been accepted as such by most geologists. Many more have been recognized on the moon and Mars by manned and unmanned space probes. Impact may be a quantitatively significant geological process, for some postulated impact structures, such as the eastern shore of Hudson Bay, are hundreds of kilometers across, and others, such as Sudbury, Ontario, are large and of economic significance.

In order to recognize impact structures, certain criteria of impact must be developed. One of these criteria, and perhaps the main one responsible for the identification of so many new impact structures, is the presence of shock metamorphism. Investigations of shock metamorphism are concerned with the changes caused by shock waves in rocks and minerals, the mechanics of cratering, and the phase equilibria and changes in structure of materials subjected for short times to temperatures above 2000°C and pressures in the megabar range. The applications of such studies to extraterrestrial structures, and to the interpretation of meteorite and tektite mineralogy, are obvious. The field is new, active, and multidisciplinary, so that by 1966 it was ripe for that mixed blessing, a symposium, and a consequent symposium volume.

The 44 papers and 10 abstracts in the book may be classified in one or more of four categories: the physics of shock waves in solids; the effect of shock experiments on rocks and minerals; the geology, mineralogy, and petrography of cryptoexplosion structures; and (each the subject of a short section) the mechanics of cratering, shatter cones, and static high-pressure experiments.

There are many good papers, and several excellent ones, which more than justify the book's existence. French's introduction is a very concise summary of the field, and his discussion of the evidence for an impact origin for the Sudbury Basin is an excellent paper that is of particular interest to mining geologists. His microphotographs are the best in the book, where the general standard is high. Chao's and Von Englehardt's papers on progressive impact metamorphism are excellent discussions, although a joint paper perhaps would have been even better. Roddy's paper as a case history of a cryptoexplosion crater is outstanding. He discusses the geology and geophysics of the structure and compares them to those of volcanic craters, impact craters, and artificial craters. In so doing he develops a set of geological and geophysical criteria for impact. Cummings and Carter present tight papers on progressive shock metamorphism of biotite and quartz, respectively.

The book is patchy. Some papers are far too long, and filled with dreary descriptive detail, even to the inclusion of well logs. Admittedly the field is at a descriptive stage, but to devote approximately 120 microphotographs and 80 pages of text to shock quartz is out of balance when one or two competent review articles would suffice. One paper devotes 13 pages to a negative result. One or two other papers are merely rehashes of talks and papers which people in the field have heard now for several years.

Now that so much descriptive work has been accomplished, the next step is the understanding of the mechanisms of impact metamorphism from the crystallographic scale to the mega scale. No doubt detailed crystallographic analysis, which was lacking in the present volume, will be performed on shocked minerals, and the studies on the nature of high-pressure glasses and their pressure-temperature histories, as presented by Bunch *et al.*, Duke, and Bell and Boyd in this book, will become more extensive. The results of a second shock metamorphism symposium in about four years should be even more interesting than those of the first. In the meantime, a textbook on impact metamorphism and cratering is needed.

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Books Received

The Archaeology of Martha's Vineyard. A Framework for the Prehistory of Southern New England. A Study in Coastal Adaptation. William A. Ritchie. Published for the American Museum of Natural History by the Natural History Press, Garden City, N.Y., 1969. xviii + 254 pp., illus. $15.

Audience Analysis for Technical Writing. Thomas E. Pearsall. Glencoe, Beverly Hills, Calif.; Collier-Macmillan, London, 1969. xxii + 114 pp., illus. Paper, $3.95.

Audio-Tutorial Introductory Biology: Principles. Marvin R. Barnum, Robert J. Gillespie, Arnold J. Greer, and Louise K. M. Peardon. Glencoe, Beverly Hills, Calif., 1969. vi + 266 pp., illus. Paper, $4.95. Revised version of the 1967 edition.

Basic Technical Mathematics. Thomas C. Crooks and Harry L. Hancock. Macmillan, New York; Collier-Macmillan, London, 1969. viii + 472 pp., illus. $8.95.

Beyond the Milky Way. Galaxies, Quasars, and the New Cosmology. Thornton Page and Lou Williams Page, Eds. Macmillan, New York; Collier-Macmillan, London, 1969. xvi + 336 pp., illus. $7.95. Macmillan Sky and Telescope Library of Astronomy, vol. 8. Material first appeared in slightly different form in *The Sky, Sky and Telescope,* and *The Telescope.*

The Biological Code. M. Yčas. North-Holland, Amsterdam; Interscience (Wiley), New York, 1969. xiv + 362 pp., illus. $11.95. Frontiers of Biology, vol. 12.

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